Summary Reports

of

Instructional Development Advisory Committee

Sponsored

Faculty Projects

for

Fiscal Year 1989

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This report contains summary reports of faculty research projects selected and supported by the Instructional Development Advisory Committee during Fiscal Year 1989.

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Foreword

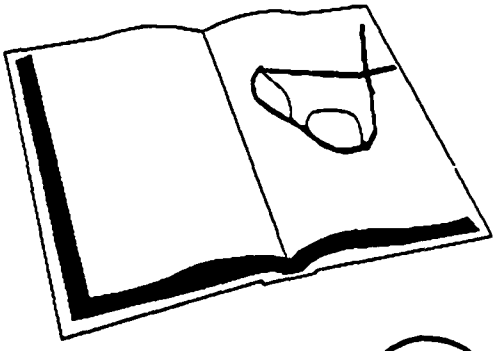
The mental development of midshipmen at the Naval Academy occurs in the classroom, laboratory and library, and through faculty efforts to improve instruction through the use of computers and audiovisual media. The Instructional Development Program, begun in 1980, recently has provided strong support for faculty implementation of computers in the education of midshipmen. Funded under Naval Academy operating funds, this program has aided the rapid conversion of midshipmen and faculty to skilled use of their personal computers.

This report contains summary reports of faculty projects selected and supported by the Instructional Development Program during Fiscal Year 1989 and implemented in the classroom during the 1989-1990 academic year.

The ten publications and twenty-two presentations reported here serve to enhance the efforts of Naval Academy faculty in instructional development through national collaboration and they attest to the professional character of our faculty. In order to best utilize the resources invested here, readers are encouraged to contact faculty or the Naval Academy Research Office for more information on these projects.

Carl Schneider

CARL S. SCHNEIDER



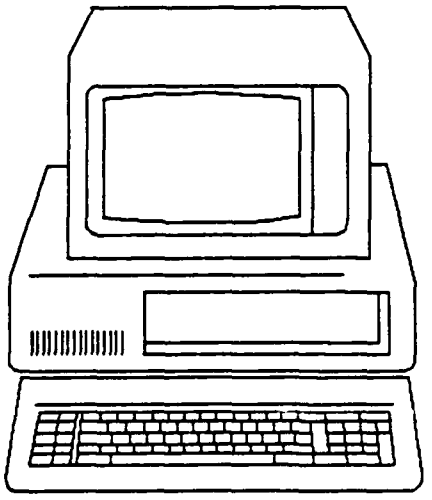


Table of Contents

PC Graphics for Engineering Geometry

Professor J. Alan Adams
Mechanical Engineering Department

Project Background

Engineering graphics and descriptive geometry in its classical forms have been largely deleted from the engineering curriculum due to requirements for computer courses. This has reduced student exposure to spatial awareness and graphical communication. This ability is still crucial for engineering design activity, and it should be reinstated into the curriculum while taking advantage of the technology and techniques made possible by computers. The elective course in computer graphics (EM442) provides an opportunity to introduce a modern coverage of engineering geometry for a limited number of students.

All First Class midshipmen owned their own PC for the first time in the 89-90 academic year. In order to properly use the available hardware, many new computer assignments and software subroutines were needed. Using computers for transfer of data files, graphical output, document preparation, assignments, class notes and homework must become normal procedure. The student must also learn to choose the proper computer tool for a given task, whether it be a PC or a high end engineering workstation. Both are available to students enrolled in the elective graphics course.

Instructional Development

The use of the PC along with engineering workstations, networking, desktop publishing, and up-to-date software in order to restore engineering geometry and spatial reasoning to the curriculum was accomplished as follows:
(a) The course EM442 was redesigned so that approximately half of the computer work is now done using the Z-248 PC owned by each student,
(b) Desktop publishing was used to produce class notes, assignments, and documents,
(c) The class was operated in an electronic environment, taking advantage of networking, ProCom, electronic mail, data handling, and the computer literacy of the students,
(d) New software packages were obtained for use on a PC which improved the quality of the graphical output and theory reinforcement,
(e) Geometric modeling techniques were developed which led to algorithmic solutions to traditional descriptive geometry problems,
(f) New techniques for animation on a PC were introduced to improve visualization skills.

Product Use, Evaluation, and Publication

As a result of the IDP development, the course EM442 now includes the use of UNIX shellscripts and C utility programs which create color graphics to support engineering design. Over twenty new subroutines, written in TrueBASIC are now in use for geometric modeling and vector algebra computations. The limitation for animation imposed by a PC have been studied, and a compromise has been identified which allows acceptable animation of planar, mechanical devices using the Z-248 PC.

Three commercially available software packages were identified and used to support the course. One was the program D3D, published by Leendert Ammeraal in the Netherlands, which gives a source C code which generates PC graphics with hidden lines and surfaces, and includes an interactive menu for generating the transformations and projections studied in class. It was used to accomplished a major design layout project using 3-D models and computational geometry calculation. The second program was MACSURF, an interactive program for creating B-spline surfaces which defines 3-D surfaces and which implements the mathematical theory presented in the classroom. The third program, MechAnimator, was developed at the University of Delaware. The U.S. Naval Academy will participate in an evaluation of this software during the coming year.

In addition to the commercial software, fifteen new programs for mechanism animation on a PC were written by the author to be used and modified by the students for mechanism layout and design. This software was the foundation for a second major design project completed by the students this fall.

The qualitative evaluation of the above software effectiveness is based upon the observed increased motivation and effort exerted by the students. From a quantitative point of view, the semester grades

were the highest in the past five years of teaching the course, even though the course is now used as an elective for general engineers as well as mechanical engineers.

One publication resulted in the IDP work this past year. "Vectors as a Foundation for Spatial Reasoning," J.A. Adams, *The Engineering Design Graphics Journal*, Volume 53, Number 3, Autumn 1989.

Participation in four additional opportunities for professional service was also made possible by the summer funding support for the IDP. (1) The researcher served as co-chairman of a heat transfer session at the International Conference on Cold Regions Heat Transfer, held at Hokkaido University, Japan in June 1989; (2) presented a guest lecture on computer graphics at Tokyo University in July 1989; (3) participated as an invited guest lecturer at the NSF Workshop on Computer Graphics held at Clemson University in August 1989; and (4) attended a one day seminar at the University of Delaware, along with other educators and engineers, to help evaluate the software package MechAnimator.

Long Term Objectives

The rapid change of computer technology requires that continual development be carried out in courses such as EM442 which attempt to present the state-of-the-art to students. The long term objective is for this course to serve as a model for the proper educational paradigm in the electronic and network environment planned for the U.S. Naval Academy. By integration of the student owned PC with other Computer Aided Design Software for Naval Architects available facilities, a complete computer experience can be part of the learning process. Additional attention needs to be placed on the technologies of solid modeling and database management if the course is to remain current. Only by such efforts can the investments in personal computers, campuswide networks, and engineering workstations be justified.

Computer Graphics for Fundamental Concepts in Course ES300*, "Naval Weapons Systems"

Associate Professor Thomas E. Bechert
Weapons and Systems Engineering Department

Project Background

This project provides computer graphics tools which permit midshipmen to grasp certain fundamental concepts which govern modern naval weapons systems operation, with better understanding than would be possible without these tools. These fundamental concepts have a common feature. They involve motion: motion of a missile or projectile, motion of a target, motion of a radiated beam, or motion of some other sort. Current techniques for explaining these concepts rely on chalkboard or viewgraph diagrams, with the appropriate motion represented by a succession of viewgraphs or by real time modification of a chalkboard diagram. These approaches are time consuming and often result in an incomplete understanding on the part of the student. Concepts involving motion are especially difficult to learn from these static displays. A quicker understanding of the fundamental principles and concepts becomes more essential as the amount of information to be assimilated continues to grow. Computer tools which provide animated graphic displays for classroom demonstration of these fundamental concepts will enhance the learning process.

Instructional Development

Several specific topics have been identified for which the graphics tools are needed. As part of this project, programs were developed to demonstrate the following topics: (1) Iterative Solution of the Fire Control Problem. A fire control computer solves the difficult problem of hitting a moving target by solving, a number of times, the simpler problem of hitting a fixed target point. With each iteration, an adjustment is made to the location of the fixed target point, based on the motion of the target during the projectile's time of flight during the previous calculation. The computational process continues until the projectile and the target simultaneously reach the same point in space. The lead angle used for the final successful iteration becomes the order from the fire control computer for the pointing of the guns.

This iterative computational process is demonstrated by simultaneously displaying the motions of the projectile and the target. The student sees them both moving through space for each iteration, and sees the succession of trajectories converge to the final solution. User-friendly pull-down menus permit the instructor to simulate many situations by modifying the target's position and velocity and the gun's muzzle velocity. Default values are provided for all parameter values to permit immediate display of a solution without any data entry by the user.

(2) Guided Missile Control Algorithms. Programs were developed for four separate algorithms for guiding missiles to intercept a moving target. These programs are integrated with a single executive program with pull-down menus which permit the user to select the guidance algorithm and to choose either a target with straight line motion or a target which performs evasive maneuvers. The student may compare the relative performance of the following guidance algorithms: pursuit, constant bearing, proportional (with variable navigation ratio) and line-of-sight (beam rider). The student sees the target and the missile simultaneously moving across the display, some missions successful and others unsuccessful, depending on the parameter values selected by the user.

(3) Radar Angle Autotracking. This program demonstrates automatic tracking in azimuth or elevation, using lobe switching to point the radar beam alternately to either side of the antenna axis, as a means of determining an error angle between the antenna axis and the target line-of-sight. The student sees an image of a radar antenna and its axis, together with beam lobes on either side of the axis, using three different colors to distinguish between the axis and the two beams. The target line-of-sight is also displayed, making clear to the student that the relative strength of the two echo signals is determined by the error angle. The program then displays the antenna rotating in response to the error signal to point the antenna axis toward the target.

All the programs will pause in their execution to permit the instructor to elaborate on the principle being demonstrated, and will then continue execution upon striking any key.

Product Use, Evaluation, and Publication

All the programs have been critiqued by the instructors of Course ES300*, "Naval Weapons Systems," by having them use the programs, without training and with little prompting by the author. The concensus was that the progams are user-friendly. Several suggestions by the instructors have been incorporated into the programs. The Fire Control and Missile Guidance programs have been tested in the classroom during the summer session and the fall semester, and have been received with enthusiasm by the students. No publications have yet evolved from this project.

Long Term Objectives

Although the above program will enhance the instructional effectiveness of the topics treated, programs still remain to be developed for several other topics: conical scan radar, track-while-scan algorithm, reference frame and coordinate transformation, and propagation interference effects. Although the programs have been developed primarily for classroom demonstration, they are also available to the students for self-instructional use on their own computers.

Basic Demonstrations for Electrical Fundamentals

Associate Professors William E. Bennett and David S. Harding
Electrical Fngineering Department

Project Background

A need exists for more good demonstrations in the Electrical Engineering core coures, EE311/312 and EE331/332. Demonstrations can clarify principles taught in the classroom and can generate more interest and enthusiasm among midshipmen for the course material. The first of two demonstrations was presented in the wires course, EE311, on 11 September 1989 to groups of two to three recitation sections at once in a large lecture auditorium. The second lecture/demo will be presented in the spring term of 1990. It was decided to test the first lecture/demo in EE311 course only because of limitations of resources. These lecture/demos were developed over the summer of 1989 with the support of IDP funds. They would not have been possible without the very strong support of Mr. Ron Ekstrom, an Electrical Engineering Department technician.

Instructional Development

The most important single item developed over the summer and used in the first lecture/demo was a large circuit board about four by six feet in size which can be easily seen in a large auditorium. This large circuit board is very similar to the board the midshipmen use in the laboratory except that it is oversized. To complement the large board, large resistors and other circuit elements were constructed by hiding actual elements under props which plug into the large circuit board. Also, two simple circuits were built which illustrate practical applications of electrical engineering fundamentals. One circuit makes use of a thermistor to produce an audible tone which varies in pitch as the temperature is changed. Ice and hot water can be used to vary the temperature of the thermistor. The other circuit uses a photocell and a transistor to turn on a small light bulb when the ambient light level dims below a certain point.

Product Use, Evaluation, and Publication

In the first lecture/demo various DC circuit principles were demonstrated using the large board and associated components. In addition, sinusoidal and other periodic waveforms were introduced. AC signals were displayed on a 37 inch TV monitor using a video camera focused on an oscilloscope display, the o-scope being driven by a function generator. The same signals were made simultaneously audible by a speaker attached to the same function generator. Thus, the concept of time varying signals was reinforced by use of sound as well as pictures. The lecture/demonstration went well and student comments were favorable. The spring demonstration for the second semester of EE311/312 will stress radar and communications principles and their importance to the Navy. Topics will include a microwave communications link and EMI, electromagnetic interference. No publication of our work is currently planned.

Long Term Objective

It would be useful to design additional demonstrations not only for a large lecture hall, but also for the classroom and laboratory. These should be a portable, permanent resource with equipment devoted for that purpose only.

Computer Aided Design Software for Naval Architects

Professor Rameswar Bhattacharyya and
Associate Professor Thomas J. Langan
Naval Systems Engineering Department

Project Background

Since design requirements for a ship can be achieved with hulls of greatly different lengths, beams, and depths, the designer's experience plays a major role in the design of a ship's hull. Much of the experience and preliminary design process is empirical. Without some guidance a young designer can easily develop a less than desirable design; however, the young designer can achieve a good design through the proper use of empirical data and extensive calculations. Students can learn empirical ship design techniques, and they can apply computers to carry them out without getting lost in the computer programming.

The purpose of the present Instructional Development Project is to provide the naval architectural majors with a computer aided design package, with which they can develop a rational design of the hulls for their First Class design projects. The intention is not to have the students simply run a program that produces a design without their understanding the naval architectural principles behind the design. Our efforts concentrated on identifying a series of rational steps leading from the design requirements to the ship lines and on developing computer programs to aid in making these steps. In the investigators approach, the design problem is formulated as an optimization problem in terms of the ship parameters needed for the development of the ship lines. The parameter values are chosen to minimize a cost function which is dependent on the ship's class and mission. This formulation of the problem requires the use of historical data to provide the cost function and the application of naval architectural principles to ensure a seaworthy and a seakindly ship. It is the student's responsibility to collect the empirical data for the design project from the literature; he or she must also formulate the cost function and express the design requirements in terms of constraint equation. In the investigators scheme, the computer merely helps to organize the data and to solve the optimization problem. It also draws the line drawings; however, it is the student who must make the basic architectural decisions leading to their shape.

Instructional Development

A complete example of an optimal design problem with a very simple cost function, one based merely on construction cost, has been completed. This simple example embodies the basic steps needed to calculate the values of the ship parameters, which satisfy the design requirements and minimize the cost function. Variations on this example will be used to introduce the midshipmen to the computer aided design software. The midshipman's first step will be to write the cost as a function of the length, beam, and depth of the ship and to express the constraints placed on these dimensions in terms of inequalities. The midshipman's programming is completed when the equations and inequalities are typed into two separate but designated files. Two programs applied to these files tabulates the typed expressions as functions relating depth to length; when these functions are plotted they guide the designer toward the optimal choice of length and depth, which because of functional relationships yields also the optimal choice of beam. Further requirements applied to the design result in additional constraints on the optimization problem; they require use of equations learned in ship dynamics or hydrostatics. A knowledge of some basic analytical geometry will speedup the solution process; however at no time does the midshipman get bogged down in computer programming.

Because cost data for tankers is readily available in the literature, the investigators have carried through the complete optimal design of a tanker. They expect that this coming Fall each midshipman in EN456 Computer Applications in Naval Architecture will use the UNIX software to design a tanker from the problem formulation through to the completion of line drawings. Having completed this assignment, the student should be capable of using the software to design any ship. He or she need only collect the appropriate empirical data and formulate the cost function to be in a position to use the design software; whether they use it for their design projects in Spring 1991 will determine the success of this IDP.

Product Use, Evaluation, and Publication

The material has not been presented to the midshipmen at this point; the first planned use is to occur this term in EN352 Resistance and Propulsion. The approach taken will follow along lines the investigators have successfully used in the past to introduce UNIX methods at this level. The programs will also be applied in the Fall in EN453 Seakeeping and Maneuvering; the full design process will be taught at that time to all the students who take EN456 Computer Applications in Naval Architecture. The first opportunity for midshipmen to use the software for their design projects will be Spring 1991; no evaluation of its effectiveness will be made before then. There are tentative plans for at least three papers: one will cover the UNIX programs and their applicability to computer aided design and scientific calculations; a second will deal with the rational design of ships and the use of these programs in executing the design; and the third will deal with the generalized spreadsheet program or shell, when it is completed. The Fall may be the earliest that any of these papers are ready, although a third of the second paper has been drafted.

Long Term Objectives

The long term objective of this work is to design a generalized UNIX program specifically tailored to the needs of the conceptual or preliminary designer. Such a program may be viewed as a generalized spreadsheet in which a cell entry could be a program or a data file as well as the usual label, number, or equation. The utilities provided with the program would combine those already available with spreadsheets with data acquisition and analysis tools and with extended graphics software. Engineers would use equations, graphics, experimental data, and natural language instructions to perform the computations needed for their design decisions and to develop the engineering graphics for the delineation of their design. Two programs developed for this project form the basis for the computational side of this generalized spreadsheet: the first program evaluates dependent variables from explicit equations and the other utilizes the first program to develop tables for the functional relationship between the dependent and independent variables. Many of the other utilities either already exist in UNIX or can be readily developed with UNIX programs. Integration of the many programs into the single program is presently progressing with completion of a prototype expected this Spring.

Support Resources for Thermal Fluids Computational Methods Course

Lieutenant Commander David A. Blank, USN
Mechanical Engineering Department

Project Background

The accelerated growth in computer utilization in engineering applications in the past decade has brought about a revolution in the engineering process. Problems considered unsolvable by classical methods of analysis are now being solved with ease through the advances in the Computational Fluid Dynamics and Computational Heat Transfer Areas. Consequently, many engineering institutions across the country are now incorporating courses in these discipline areas into their undergraduate curricula. Developing a course to equip students with these powerful new computational tools is only part of the solution. Undergraduates have trouble grasping the physics of a problem from simply viewing the raw data obtained through a computation. Enhanced learning takes place through the physical visualization of a given process. In order to maximize the learning experience of a student studying the numerical solutions of the governing equations of fluid dynamics and heat transfer, relevant physical displays of the data are essential. Plots of such things as the local velocity vectors, streamlines and isotherms for a given flow problem greatly assist the student in gaining a physical understanding of the solution he has just labored so hard to obtain. Undergraduate students in general do not have the time or background to develop the graphics programs necessary to display such results. Thus, the need was identified not only for the creation of a course in the thermal computational methods area, but also for the development of support software for such a course.

Instructional Development

An extensive review of the discipline area has been conducted along with a review of available resources (texts, software, etc.) and a final syllabus for the course has been developed. Also, a series of problems have been put together which support and enhance the content of the course. A number of software packages have been written in the "C" language which will run on the Engineering Computer Center's "VAX" and on the more recently acquired "SUN" computer workstations. Also programs have been written to enable the student to do parametic studies of the solutions for a number of the problems assigned, and which enable the student to compare the accuracy of different types of numerical solutions with known solutions. Figures 1-4 show examples of some of this software.

Product Use, Evaluation, and Publication

The course approach and a large portion of the course content was tested on a TAD USNA Ensign over a two month period and with very good results. During this testing period, the use of feeder programs was evaluated as a means of teaching the student advanced programming. In the beginning this approach of giving students fairly sophisticated code examples that solve problems similar to the ones they are assigned, results in a rapid mastery of the fundamentals of a new language in a very short time. The investigator has tested the use of this approach on a total of three TAD Ensigns (1) to learn FORTRAN and (2) to learn "C." The Ensigns using "C" wrote the graphics packages that produced Figures 1-4 herein. A class of 1990 Mechanical Engineering major is presently moving through approximately 25% of the course material in an effort to gain the tools needed for a independent research project he is working on. To date, the entire course has not had the opportunity for classroom testing.

Long Term Objectives

The course has been developed in such a way as to make it a capstone experience for the student in the themal fluids area. It is ultimately intended that the course be able to equip students not only with the computational tools necessary to tackle difficult thermal fluid problems but also, to enable the student to use these tools to optimize thermal fluids processes.

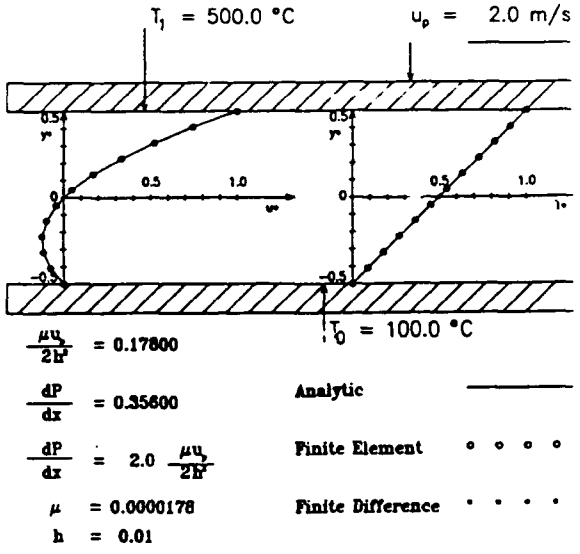


Figure 1.
Poiseuille Flow Solution Method Analyzer.

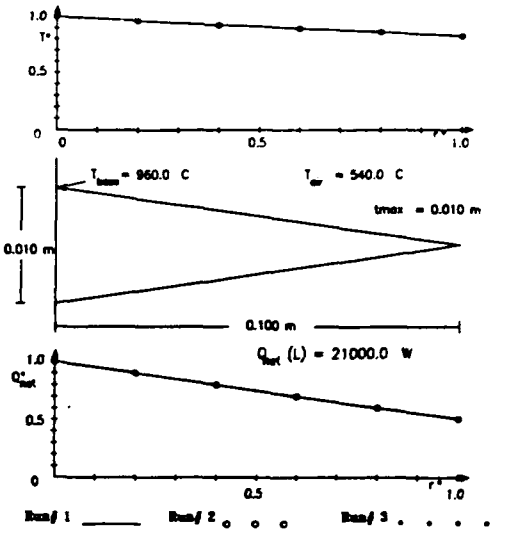


Figure 2.
Fin Heat Transfer Solution Method Analyzer.

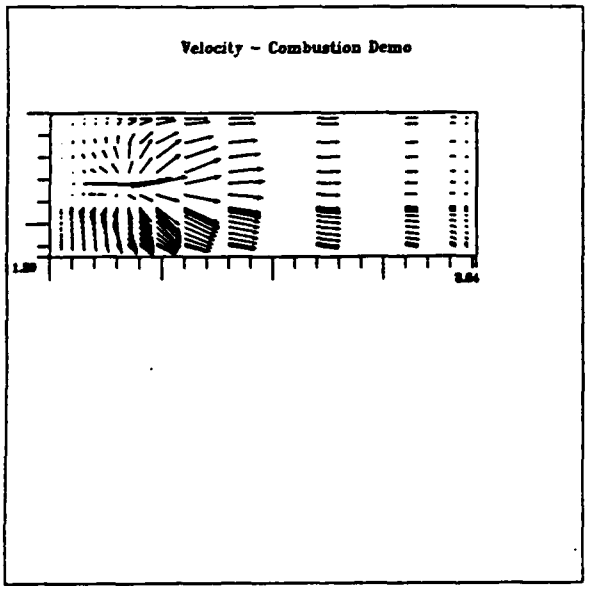


Figure 3.
Adaptable Vector Plot Field.

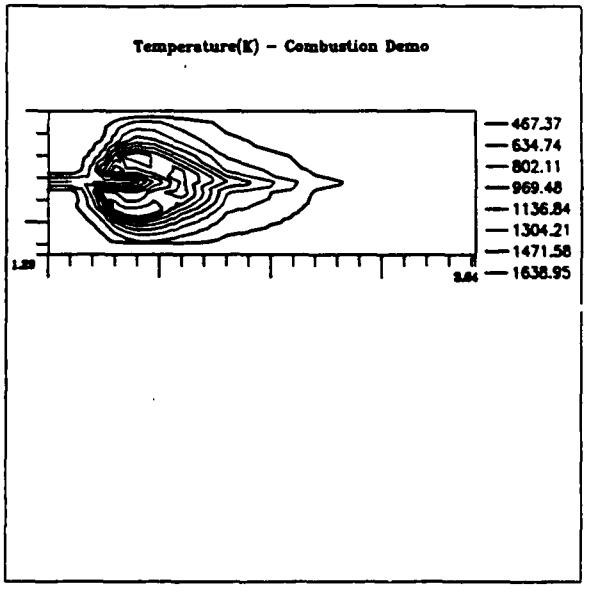


Figure 4.
Adaptable Isobar Plot Field.

ET100 Firmware Modification, and 80386 Software Evaluation

Associate Professor C. George Brockus
Weapons and Systems Engineering Department

Project Background

This project consisted of two parts. In the first part, the Weapons and Systems Engineering Department has used the Z-100 microcomputer in several courses: ES451, Robotics and ES414, Sampled Data Control systems being two of those. The machine was admirably suited to those applications because it is built around the S-100 bus. That bus system lends itself readily to analog/digital and digital/analog conversions in the analog data taking environment. The department has much experience with that system, and many cards for use in that system. The computers are also used in a sequence of courses ES408, Digital Technology and ES442, Microcomputers in Control Applications.

The use of microcomputers in that sequence of courses begins with an excellent instructional computer, the ET100 Learning Computer from Zenith. This computer has a bread-board area, and provides ready access to the bus lines for data and instructions. This computer comes with a key-board monitor, an Assembler, and a De-bugger so that it is easily applied to learning applications, and to experiments in interfacing. However, the Firmware supplied with these computers is based on CP/M-86, an operating system different from MS-DOS.

The De-bugger and Assembler which are supplied with the latter system, and the DOS commands which replace those of the key-board monitor on the ET100, have personalities different from that of their counterparts on the ET100 system.

The firmware of the ET100 was modified over the course of the project, in terms of the monitor commands. The assembler modification proved to be too difficult a hurdle in the absence of source code. An Ada Cross-Compiler was sought to make the latter modification tractable, but the cost was too high to be borne under O&M,N funding. The movement of the department away from the Z-100 systems alleviated the problem.

In the second part of the problem, the Z248's which have been provided for the midshipmen, and widely throughout the yard to faculty and staff as well, are 16-bit machines which do not represent the state of the art in personal computers. Many companies are now providing machines based on the 32-bit 80386 microcomputer introduced in 1985 by INTEL.

Software development moved at a slow pace for these powerful machines. MS-DOS proved to be one of the major obstacles, since it was designed to limit access to 640K of memory. Other operating systems are available, and XENIX by Santa Clara Operations is an attractive one based on AT&T's System V Unix.

An investigation into operating systems available led to the choice of the SCO XENIX. It exercises the full capabilities of the 80386, and provides the capability of running MS-DOS software. The latter feature will permit the use of all of the applications programs which have been found useful in the past. That system was acquired, possession coming in late August 1989.

An additional acquisition was made. A native Ada compiler was ordered, and came on board late in October 1989. The native compiler is not as useful as the cross-compiler referred to above, but moves the department in the direction mandated by DOD for future language usage in engineering. This compiler will reside in the XENIX host described above, will provide executable programs in the native code of the 80386 machine, and will permit program development to be carried on in the hightest level development language currently available.

It is anticipated that the department will move in the directions initiated by the efforts of this project; certainly in the area of operating systems, and perhaps in the area of Ada.

Instructional Development

The applications of this project to the curriculum of this department are immediately apparent in connection with the courses listed above. That effect was diluted due to the rapid movement of the department away from the Z-100 systems which were in use at the project's inception.

The direct application of the Ada compiler is anticipated as a future project to develop a missile simulation to be used in a design project for ES400 and ES410. That application has been proposed in other documents concerning the development of the Core Curriculum at the Academy. The design project would be of great value to future naval officers as they consider the development of weapons systems for the service.

The second portion of this project, although more tenuous in its proposal and anticipated value, has proved to be the more valuable portion of the

project. The software located to give direction to the department's future, and the acquisition of the Ada development language will provide highly attractive resources for the department's future at the Academy.

Product Use, Evaluation, and Publication

The evaluation of XENIX and Ada is a continuing process. No publications have resulted.

Long Term Objectives

Development of a missile simulation in support of the Core Curriculum.

A Teaching Package for Numerical Methods and Analysis

Associate Professors James L. Buchanan and Peter R. Turner
Mathematics Department

Project Background

There is at present no suitable published course material for the advanced numerical analysis courses (SM425 and SM426) which is appropriate for the Turbo PASCAL computing environment. The main aim of this proposal is to produce course materials - notes, numerical algorithm code and graphics support. A secondary purpose is to identify those areas of numerical mathematics which would be most appropriate for a practical treatment in introductory courses in scientific computation for presentation to science and engineering majors.

Over the last several years the methods of computer solution of the mathematical problems arising from modelling of physical situations have been steadily growing in importance. The range of problems which use scientific computation in their solution has grown along with the availability of computing power. However the mathematical texts for the teaching of this material in undergraduate courses has remained firmly fixed in the use of FORTRAN as the primary programming language. The widespread - and, importantly, the local - use of Turbo PASCAL has been largely ignored thus far. It is our intention to rectify this situation.

SM426, Numerical Differential Equations, has posed a particular difficulty in that approximating differential equations numerically can involve root finding and solution of linear systems, neither of which can be covered well within the course if students must program the methods themselves. If libraries were available which could be linked into student programs only a brief discussion of such methods would be necessary. Moreover, a greater number of methods of approximation could be discussed and compared.

It is certainly not just coincidence that during this period of the simultaneous lack of appropriate teaching materials and the Naval Academy's computer revolution the computer track of the Mathematics major has not been successful in attracting large numbers of able midshipmen into this important area. The development of good text, software and support materials tailored to the needs of our students should be an influential step in reversing this process in the new Scientific Computing concentration.

Instructional Development

The primary development is the production of textbook-quality course notes together with Turbo PASCAL Version 5 computer programs and associated graphical software packages. The first priority for these is that they should be suitable for the two SM425 and SM426 in the fall and spring semesters of the next year. The researchers have purchased other software such as the NAG Pascal library and Numerical Recipes for evaluation.

Thus far some 450 pages of the text material has been developed from the material currently covered in the courses and the supplementary notes already used. The programs the researchers are writing take advantage of the new facilities offered by Turbo PASCAL Version 5 (and 5.5 and subsequent versions) such as the ability to pass functions into procedures. It is the lack of this ability in earlier versions of Turbo PASCAL which has meant that even the existing good software such as the Numerical Recipes package is of little assistance since it does not allow large realistic problems requiring the use of more than one of those procedures to be solved. It is also the case that such packages consist of "finished programs" and so its use does not give any real idea of the considerations which go into the development of scientific software.

The programs the investigators are developing include some similarly polished work but will also include simple programs to help the midshipmen in their understanding of the development and construction of such. They also intend that the final versions should be sufficiently well-organized as to be used as procedures within more extensive programs. By the end of the two courses it should therefore be the case that students would have a good and realistic understanding of the broad aspects of the subject together with useful experience in building complex programs to solve real-life problems using our programs as significant building blocks. The supporting graphics package is a further development of the work done by Buchanan under his 1988 IDP grant.

Product Use, Evaluation, and Publication

The first five chapters together with four appendices were used as the primary text in the SM425 course this fall while some of that material together with two or more subsequent chapters will be used as the text for SM426 in the spring. Some of the material will also be included in the revised SM364, Introduction to Scientific Computing, which forms part of the remodelled Scientific Computing concentration within the Mathematics major. Student opinion together with the views of colleagues - both here and at other institutions - will all play important roles in the evaluation of the material.

Three presentations were given during the summer and fall - one at West Point to the Joint Service Academies Conference on Computers in Mathematics in June, one to the Society of Industrial and Applied Mathematics National Meeting in San Diego in July, and the third to the Mathematical Association of America at the regional meeting in Washington in November. In all cases there was considerable interest aroused in, and some enthusiam for, our attempts to provide a quality instructional package for undergraduate numerical analysis.

Long Term Objectives

Although the investigators have made considerable progress towards set goals, there is still much to be done on several different fronts.

There are still major areas of the subject which the researchers are unable to cover satisfactorily in SM425 and 426. Most notable among these perhaps is numerical linear algebra. This will be alleviated as soon as SM364 comes "on stream" to provide the essential introduction, background and programming skills in a "broad spectrum" numerical methods context. The text for some of these additional topics is still to be written.

Many of the programs are at this stage still in "one-off" form to illustrate the techniques discussed in the courses and in the text. It will be an important step forward to incorporate these into a useful software library - probably as a collection of Turbo PASCAL units. The graphics package is close to this level already while the units for solution of equations, linear equations and interpolation are substantially complete.

Probably the biggest single challenge is the development of material on parallel computing. The impact of parallelism (of all types) on numerical computation is already enormous and bears not just on the final implementation but on the choice, organization and computational analysis of methods. It is inevitable that by the time most of the midshipmen taking courses in scientific computing are in positions to use those skills in the Navy almost all serious computation will be performed on parallel machines. After acquiring the necessary experience and expertise of parallel computation - either on hardware or using software simulators, we intend to integrate material on parallel scientific computation into the courses - or as an additional offering within the Scientific Computing concentration.

In addition to the topics alluded to in the second paragraph, it is desirable to produce text material and progams for other areas of numerical analysis - such as optimization and approximation theory which would conventionally be included in a text even if not always forming part of an undergraduate course. Our midshipmen should not be disadvantaged in any way by having an "in-house" text.

A User's Manual for Employing the Computer in Quantitative Analysis in Naval History

Professor William L. Calderhead
History Department

Project Background

For the past two and one-half years the researcher has used the computer in midshipmen research projects assigned in the American Naval Heritage course and the seminar course for history majors. These projects worked out well, but the experience involved uncovered a need for some kind of guide that the midshipmen could use in applying computer techniques to historical analysis. Since no really effective guide exists in the field of history for using the computer for quantitative analysis, the researcher's plan was to write a guide or manual that could be used in such courses.

Instructional Development

During the summer of 1989 five weeks were spent in putting the guide or user's manual together. It comprised: (1) an introductory chapter that described the applicability of the computer to historical research and offered suggestions to the student for getting started: (2) a chapter on how the computer has already been used effectively in various fields of history: (3) a chapter presenting a model program that explains to the student a step-by-step approach for gathering material, establishing a database file with this material, and using mathematical formulas (all by computer) to analyze the historical information in a meaningful way. The final two chapters presented a brief bibliography of articles that had applied computer analysis that have appeared in scholarly journals. This was followed by a discussion of how such a computer-based approach could be applied to various areas of research in the basic history courses at the Naval Academy.

The remaining weeks of the summer of 1989 were spent in gathering material to establish a database for the midshipmen to use in the history seminar course (HH262) that the researcher would teach in the fall. The theme of the seminar involved a critique of the tactics and strategy involved in submarine operations in the Pacific in World War II - a critique based on computer-supported quantitative analysis. Each of the students took a specific phase of the submarine war (the Guadalcanal campaign, the Aleutian, sub operations in Empire waters, etc.). Oral reports and an oral summary at the end of the course tied the separate themes together into a composite picture.

Product Use, Evaluation, and Publication

The manual was effectively employed in the HH262 seminar as well as the two sections in Naval Heritage. Chapter III that discussed the model program was particularly helpful.

Since the manual has been of practical value, it is being used again this spring semester (1990), and plans are to continue using it in history courses in the future.

As for publication, since the manual is tailored for special needs (midshipmen in basic history courses), it does not have broad or universal application, and publishing it would not be practical. But, a theme dealing with the seminar project this past fall, namely, tactical use of submarines in the Aleutians campaign in 1942 is being more fully developed in the form of an historical article. When finished in late 1990, it will be submitted to a journal for possible publication.

Long Term Objectives

The current database comprises a great deal of information on all of the American officers (about 500) who commanded submarines in World War II. Midshipmen studies, done in earlier classes have indicated that it is possible to employ the data to show that a correlation exists between success in sinking enemy ships and quantifiable data about each skipper such as age, submarine school rank, aggressiveness, etc.. The researcher is planning to extend this analysis (using the computer as a screening device as a predictor of success in combat) to the destroyer commanders (about 1,000 officers) of World War II as a long term objective to be used for future midshipmen research themes.

Self-Help Tutorials in Probability and Statistics

Professor Michael W. Chamberlain
Mathematics Department

Project Background

Simulations, demonstrations, and interactive experiments involving random phenomena are an essential part of any introductory course in probability theory. This is the time when the student moves away from predictable, deterministic experiments and begins to make (mathematical) sense of likelihood, expectation, estimation, and decision making when confronted with the unpredictable. The primary goal of this IDP is to provide a collection of self-paced computer "tutorials" that help the student see what the problems are, what tools are used, and how they work.

Instructional Development

Most of the tutorials cover some common topic of probability and statistics. This might be computational drill, a simulation of a random experiment, a demonstration of how well theory predicts reality, or a graphical interpretation of a theorem. Some tutorials introduce topics outside the scope of the course, such as applications of probability theory to statistics and reliability theory, or an introduction to the generation of pseudo-random numbers and their use in modeling random phenomena.

The tutorials are designed to run on the midshipman issued computer. They are chosen from a menu, and the user is prompted at every step. When possible, the user guides the development of the topic with responses, choices, guesses, and the like. The computer's job is to provide very colorful and graphical images that introduce or reinforce the topic at hand. And by having the computer randomly alter the parameters in every run, most lessons are repeated without duplication.

Along with the tutorials, a new piece of software has been developed that should have a significant impact both on classroom presentation and student calculations. This program allows the user to choose from among a dozen standard distributions, input the parameters of the distribution, then have the computer produce the desired probabilities (discrete table or continuous area) and display the corresponding picture (histogram or density curve) with pertinent regions highlighted in color.

This means the student can solve problems without using tables or repeatedly resorting to integral calculus. It also means that the student can investigate *significant*, real-world problems that in the past would have been computationally impractical to solve. And with each application, the student sees what the distribution looks like both in terms of formulas and graphs or histograms.

The instructor can also use this software in class for quick computations. And because two distributions can be shown simultaneously side-by-side on the screen, the instructor can compare distributions for his class visually. For example, he might wish to show how parameters change the shape of the distribution, or how different distributions can have approximately the same shape (e.g., the Central Limit Theorem).

In addition small, short simulation programs are being produced to help the instructor convince his students that the theoretical (and perhaps nonintuitive) solution to a certain problem does indeed agree with experimental evidence. These are particularly helpful in the early stages of the course when the exercises involve games (played with coins, dice, and cards) or conditional probability.

Product Use, Evaluation, and Publication

This software has been thoroughly integrated into Probability and Statistics I (SM239). Computer assignments appear in the lesson assignment sheet in order to match the textbook development. Computational drill comes from a 20-problem set of advanced numerical exercises. These also serve to introduce important distributions that cannot be covered in class.

The students run the tutorials and hand in written reports that explain what the lesson was about and what its goals were, how well those goals were achieved, and any constructive criticism they might have. This scheme works very well. The students must put forth individual effort, must think and respond about what they were to learn, must write a literate report, and often end up providing valuable suggestions that improve the product for future users.

Long Term Objectives

There is still work to be done in constructing tutorials on: demonstrations and drill on counting techniques; conditional probability and Bayes' Rule; elementary and graphical explanations of variance and covariance; simulations demonstrating reliabilitly theory; acceptance sampling; nonparametric statistics; Markov chains; queuing theory.

When NADN is fully operational, all this material will be made accessible to midshipmen directly through their personal computers. The long range goal is to produce an interactive study program based on a modern expert system so that midshipmen can be intelligently guided through topics with a high degree of interaction and at a level, speed, and scope suitable for the user.

Revision of the Laboratory Course Content and the Laboratory Manual for General Biology

Professor R. Reece Corey
Chemistry Department

Project Background

It was proposed to evaluate the current laboratory exercises in order to update the subject matter and to improve the coordination of material between the classroom and the laboratory. Secondly to increase the amount of experimentation and decrease the amount of observation, and thereby increase the active participation of the midshipmen in the laboratory exercises. Thirdly to incorporate the use of computer programs, particularly in genetics, taxonomy, and ecology where the computer would by very effective, e.g., solving genetics problems and mating experiments, and ecological modeling. Fourth to redo the tapes of the "Biology Theater" which are now 14 years old.

The first course in Biology was offered at the Naval Academy in 1965 with the introduction of the minors program. It was subsequently modified with the introduction of the majors programs as a required course in the Oceanography major. It has remained substantially unchanged since that time, other than two revisions of the laboratory manual. The TV tapes used with the laboratory were made a part of the General Science major and a lot of computer software has become available from commercial sources. Furthermore, a deal of new information has been incorporated into the lecture syllabus which has thrown the synchrony of the lecture and laboratory material out of phase. The revised laboratory experience should be current and of more relevance to General Science majors without decreasing its value to Oceanography majors.

Instructional Development

The laboratory manual for General Biology I was revised and its focus reoriented. Six exercises were extensively revised and seven new exercises were written. The new manual emphasizes experimental data acquisition and manipulation. Three exercises require the experimental data to be plotted, and one exercise requires the experimental data to be analyzed by statistical methods, i.e., the chi square test. One exercise requires the class to determine the frequency of a pair of alleles in the class and compare this random sample to the frequency in the population as a whole. The computer is then employed to select for or against several phenotypes and for varying number of generations, thus simulating the effect of natural selection and random events on gene frequency.

One new exercise requires the use of a dichotomous key to identify unknown organisms and then to study and describe them. Four exercises, that were extensively revised, cover information about the plant and animal kingdoms and are now arranged to compare function, reproduction, evolution, and ecological relationships rather than the traditional heirarchical survey by phyla. In general the focus has been shifted to the experimental rather than the descriptive aspects of Biology.

Product Use, Evaluation, and Publication

The laboratory manual was printed by the copy center and used in six sections of General Biology for the fall semester of academic year 1989-1990. Some minor modifications were made after evaluation of the time required for the midshipmen to complete each exercise, and typographical errors were corrected. A commercial program was available for the computer generated laboratory and it is being made a part of the book requirement for the spring semester. The possibility of a site license for this program is being explored. The final edition of the manual will be sent to the print shop and available for the fall semester of academic year 1990-1991.

Long Term Objectives

Television tapes to accompany the laboratory manual have yet to be produced. A number of computer programs in genetics and ecology have been reviewed and work is in progress in these areas. Use of a desk top publishing program is contemplated to format the final edition of the manual.

Communicating Mathematics

Associate Professor Carol G. Crawford
Mathematics Department

Project Background

This project was a continuation of the 1988 IDP project of Professor C.C. Hanna, Mathematics Department, and Professor P. Sine of the English Department. In the past, midshipmen have received minimal instruction in the use of mathematical language and have had few resources to learn it on their own. This lack seriously undermines the depth and rigor of advanced mathematics courses. The major goal of this project was to develop a graduated series of modules to help midshipmen understand, communicate, and apply the formal language of mathematics. The original plan of this project provided for materials which would be available in both written and videotaped form to midshipmen for instruction and review, and to faculty in the Mathematics Department and Writing Center. These materials could serve as resources for in-class presentations as well as extra instruction.

Instructional Development

In the first phase of this project the investigator conducted an updated search of the literature to discover current approaches to the problem of teaching the formal language of mathematics. Numerous conferences and journal articles have been devoted to the problem of writing and expression in all disciplines. The particular difficulties associated with understanding and applying the language of mathematics is currently receiving wide attention. Thus, in addition to searching the literature, the investigator communicated with other researchers developing programs and materials for this area. A linguistic approach to mathematics is still a relatively new concept and the ideas of this project are continuing to generate much interest.

The major goal of the project was the development of modules and exercises to give midshipmen practice in reading and writing mathematics. This development included two major objectives. The first objective was to revise and expand the original set of written modules created during the 1988 IDP project. This revision has included the creation of additional modules, numerous exercises and more materials designed to present specific methods for understanding and applying mathematical language. As stated above, originally the project was designed to create materials to be presented in written and video-taped form. The second objective of the 1989 project was the adaptation of these materials for use on personal computers. Thus, midshipmen and faculty alike would be able to better utilize these materials both in and outside of the classroom. The modules and exercises are now included as a software package which midshipmen can view on their own computers.

Product Use, Evaluation, and Publication

In the fall of 1989, the Mathematics Department offered a new sequence of mathematics courses for the math major, SM291-SM292. A major goal of this course if to devote considerable time and energy to teaching math majors to read and write mathematics. As a prerequesite to Advanced Calculus this sequence is designed to give midshipmen practice in writing proofs and reading and understanding technical and theoretical materials. Many of the modules and exercises of this IDP project have been developed to meet the particular needs of the math majors in SM291-SM292. A paper by this investigator entitled "Mathematical Literacy: Reading and Writing Mathematics" was presented at the Penn State Conference on Rhetoric and Composition, July 1989. The paper, an outgrowth of this project, was presented as one of a three part session related to writing across the curriculum. Professors Hanna and Sine presented the other two papers. This paper has been revised and submitted for publication.

Long Term Objectives

The software package developed from this IDP project should serve as a useful tool for midshipmen and faculty alike. Although some emphasis has been given to the more urgent needs of the mathematics major, these resources should aid all midshipmen in understanding and applying technical language. These materials will be available for in-class as well as personal use at the Academy. A long range goal is the adaptation of this package to one with an interactive format that would allow the user to query materials and recieve online feedbac A commercial package "Hyperties," which has bec produced by Cognetics Corporation in Princeto.., could be adapted to provide this capability.

Self Defense for Women, A U.S. Naval Academy Physical Education Department Combative Component Series 1

Associate Professor Jan B. Dainard
Physical Education Department

Project Background

The United States Naval Academy Physical Education Department and the Academy itself, had no current or updated materials presently on hand on Self Defense for Women. The courses we instruct at the Academy are useful to the midshipmen, both in their military duties and as a civilian. The project enhanced our abilities to teach this course to the women midshipmen by use of videotape, along with instructor direction during plebe summer, academic year and during make-ups.

Instructional Development

The course curriculum for Self Defense for Women was pulled apart and broken down into easy step by step instructions and was videotaped by the Educational Resource Center on 19 July 1989. The course instruction was demonstrated during the videotape session by the researcher and two other women instructors in the Physical Education Department: Lieutenant Nancy Hoffmann and Instructor Carol Martin. All techniques of seven combative components were broken down and explained and demonstrated step by step on the videotape: stretching, falls, stances, kicks and blocks, punches, judo throws and chokes and releases. A section was devoted to combative grappling movements.

The Educational Resource Center and the researcher went through the videotape and cut and added areas to make the course instruction tape as easy to understand as possible.

The Educational Resource Center finished editing the videotape and sent four completed copies of the instructional program to the Physical Education Department on 11 December 1989. A copy of the videotape is in our chairman's, Edwin Peery, office and three copies are in the researcher's office.

Product Use, Evaluation, and Publication

"Self Defense for Women, A U.S. Naval Academy Physical Education Department Combative Component" will be used for instructional purposes at the U.S. Naval Academy, in the Physical Education Department Curriculum for fourth class women midshipmen. It will also be available in the Nimitz Library for any midshipmen, faculty or staff to view. The video will be used in the second semester academic years, plebe summers, and for make-up instruction.

The Physical Education Department Chair and myself will be evaluating the construction and usage of this videotape during the current academic year. At this time there is no evaluation of this project until we can utilize the project in an academic setting, which will begin the week of 5 March 1990. After reviewing the completed instructional videotape, the researcher found that it will be of tremendous use to the Self Defense For Women curriculum this coming spring semester and in the incoming plebe summer class.

This Instructional Development Program on Self Defense for Women will only be used, at this time, for in-house use at the U.S. Naval Academy for instructional purposes only, by the Physical Education Department.

Long Term Objectives

To be able to utilize this project in all phases of our combatives instruction for women midshipmen at the U.S. Naval Academy. Especially in the areas of Plebe Summer Self Defense Curriculum and have it readily available for make-ups and extra instruction during the whole academic year.

A long term goal is to have all of our Combatives Curriculums: Hand to Hand, Judo and combatives put on videotape for instruction, extra instruction and make-ups for the Physical Education Department.

Incorporation of Computerized Data Acquisition Into ES306: Applied Control Systems and Instrumentation

Professor Robert DeMoyer, Jr.
Weapons and Systems Engineering Department

Project Background

The major thrust of the course is to carry out the following sequence: (1) Take measurements of inputs and outputs of each of the components within a control system, (2) Using techniques developed in class, estimate parameters from these measurements which characterize the components, (3) Based upon the estimated parameters, mathematically predict the time response of the control system, and (4) Obtain the actual response and compare it to what was predicted. In the past, measurements were taken by hand, typed into the departmental minicomputer, and analyzed by student written programs in PASCAL.

Instructional Development

The researcher was fortunate to procure a set of computer controlled oscilloscopes which are capable of carrying out the measurements required for the course. Measurement capabilities include voltage waveforms, rms, peak to peak, maximum, and minimum. Computed quantities include frequency, period, rise time, and fall time.

While the scopes can be computer controlled, the software required is tedious and difficult to write. However, in order for the students to have a good feel for what is being done, it is essential for them to do some control software programming. An important part of this project was to develop a software library which greatly simplifies the programming. The student programs, using this library and running on the Z-248, will cause the scope to take data and then to pass it along to MATLAB.

MATLAB is a matrix oriented language with excellent graphics. It is well suited to the required parameter estimation. The students will write MATLAB programs to input data measured by the scope, estimate the required parameter, and plot both the discrete data points and the fitted curve.

In the past, comparison of predicted to actual time response was limited to the comparison of rise time, peak overshoot, and frequency oscillation. Now, it is possible, on the same axes, to plot an entire time response as well as the mathematically predicted response. The quality of the results is excellent.

The following laboratory exercises were developed as a part of this IDP: (1) Histogram Display of Random Data, (2) Data Generation and Parameter Estimation, (3) Servo Component Familiarization, (4) Servo Component Parameter Estimation, (5) Time Response, (6) Frequency Response, and (7) Compensator Design. In all cases, the lab handout has been prepared, software to be supplied to the students has been developed, and the complete lab solution has been carried out.

The overall value of this project to the students is summarized as follows: (1) It serves as an introduction to the world of computer controlled instrumentation. These are techniques currently used in industry to replace the obsolete manual handling of data; (2) The student programming, both of the scope and the estimation routines, is designed to emphasize the principles while minimizing the more tedious and routine work; and (3) The quality of the results has been greatly enhanced. The results will tend to strongly verify the theory.

Product Use, Evaluation, and Publication

The labs will be used in ES306, spring 1990. They will be evaluated by the instructors before the beginning of the semester, and by the students during the semester. Publication is comtemplated in the ASEE Transactions on Computers in Education.

Long Term Objectives

While this work has covered the course objective to mathematically characterize the components of an actual control system, the course objective to study instrumentation requires further work. It will be required to develop a series of labs on instrumentation and electronic support circuits.

Development of Computer Demonstrations, Laboratories and Algorithms for the Communications Area in Systems Engineering

Associate Professor Terrence E. Dwan
Weapons and Systems Engineering Department

Project Background

During the past decade the fastest growing area in the communications field has been data communications. This burgeoning technology will soon be on board ships in the form of small local area networks (LANs) connected or linked together by fiber optics. Because of the very recent upgrade of computer equipment throughout the Weapons and Systems Engineering Department, they are in an excellent position to introduce these important topics in the data communications area to the midshipmen.

Also, several relevant topics such as system identification techniques, spectral analysis and the signal processing of information in the presence of noise needed to be added to the curriculum in the form of new laboratory experiments/demonstrations. The midshipmen need to be exposed to some of these ideas. But until just recently, the equipment/software/support to develop these instructional areas did not exist.

Instructional Development

The update of the Communications Area is proceeding on two separate fronts. A brief explanation about each of these developments would be appropriate.

The Network. A laboratory Ether Net is now in place. It connects each terminal (eleven altogether) to every other terminal in the typical bus configuration. Each of the terminals is also connected to a Micro/VAX which is currently serving as a file server. We plan to expand the MircoVAX's functions into some networking soon. A course file for both communication courses in one of our elective tracks in Systems Engineering has been created on virtual course computer reference for each midshipman in the course. He or she accesses these files over the network. Timing and blocking studies are currently being undertaken to see how the network will perform in a laboratory situation with multiple users.

Laboratory Development. A complete new set of laboratory exercises has been developed over the past several months to introduce the midshipmen to concepts in signal processing, spectral analysis and system identification. As part of this IDP a two-laboratory sequence on Monte Carlo simulation has also been developed and the complete solution and programming carried out. These exercises range from rather simple introductory examples to fairly sophisticated topics such as matched filtering, FM spectrum generation, real-time system identification, etc. The data files and software packages required to implement these laboratory exercises are, of course, available to the students over the network on the course virtual disk.

Student Value. The overall value of this project to the midshipmen is as follows. It introduces the midshipmen to topics destined to play a large role in shipboard communications in the future Navy. These developments will present to the students a laboratory demonstration which they help design and conceive to illuminate rather esoteric theoretical ideas. Nothing beats a laboratory experience to help nail down a theoretical concept. The equipment, computer stations, network, etc., offer them a marvelous state-of-the-art laboratory experience.

Product Use, Evaluation, and Publication

The products and laboratories will be used partially in ES412, fall 1989 and extensively in ES406, spring 1990. Continual evaluation by our instructors and technicians and, of course, by the midshipmen during these semesters will provide the necessary feedback for evaluation and improvement. Publication is contemplated in the IEEE Control Systems Magazine.

There are several areas which still need to be addressed. Passing of packets computer-to-computer, implementation of the network traffic analyzer for study purposes, demonstrations with the network trouble-shooter involving the students are just a few of these areas.

Development of Course-Enhancement Tools for the SP328 and/or SP411 Courses: Phase II

Professor Samuel A. Elder
Physics Department

Project Background

Fluid Physics (SP328) and Sonar (SP411) are taught by the Physics Department primarily as service courses for other departments. Typically each has on the order of 100 students or more. Both are three-hour per week courses and therefore do not provide the experimental, hands-on laboratory experiences that are generally considered to be essential to good physics teaching. The idea of this project has been to come up with ways to provide lab-like experiences without adding any extra contact hours. Some of the products that have come from Phase I are tutorial materials for out-of-class projects and classroom demonstrations. During Phase II concentration has been on the development of graphics-oriented computer experiment simulations to be performed on student pc's as homework. Specifically it was proposed to utilize the new Mac II computers recently purchased by the Physics Department in order to develop graphics-oriented and animated student exercises that could be performed either on the Physics Department Mac and Apple II computers or on student Zenith-248 pc's. Some time was spent gaining familiarity with such standard Mac packages as *hypercard* and *VideoWorks II*. In the end it was decided that the best medium for the type of tutorial materials envisioned is the CMU-developed language cT, which is a state-of-the-art CAI tool. Its versatility, transferability between computer systems, and special features for animations and computer-student tutorial interactions make it ideal for generating lab simulations to be performed on the Zenith desktop. The cT compiler did not arrive in time to utilize it during the Spring semester, however.

Instructional Development

As mentioned above the investigations beginning in January 1989 initially concentrated on a search for an appropriate medium to perform the work, resulting in the selection of the cT computer language as the ideal choice. During the summer of 1989, the investigator learned how to write programs in cT, using prototype Mac-version 1.0 of cT together with instructional materials supplied by the vendor. Five complete student tutorial programs were composed during this period. At the end of the summer a more up-to-date version of cT arrived along with the first compiler for the MS-DOS version. During the Fall 1989 advantage was taken of newly-acquired capabilities of cT Version 1.1 to add color to the animations and to convert the first five programs into MS-DOS text.

The first five student tutorial programs have now been made available on 3.5" or 5.25" diskettes and are saved in binary, compiled form. An "executor" program is supplied with each 3.5" diskette to run the compiled programs, along with a file containing all the "icons" used by the programs, and several auxiliary files. Icons are composite objects that can be manipulated by a single command. An explanatory booklet has been written to accompany each diskette. For the newer Zeniths (USNA class of '92 and later), cT programs may be operated directly from the 3.5" floppy drive; for older machines, using 5.25" diskettes, a hard disk is required to accommodate the executor program.

The first program is a drill-routine to assist the student in learning how to analyze a physical quantity into dimensions. Based on a Dimensions Table in the Fluid Physics text, it provides an exercise on the length, mass and time dimensions of the basic mechanical and thermal quantities used in the course. Correct/incorrect responses receive appropriate verbal and visual reinforcement. The rest of the programs use schematic drawings of apparatus which can be stretched, moved or otherwise manipulated by the student, using a mouse, and on which simulated physical measurements can be performed. There is a simulated Manometer Experiment in which the student measures the readings of a U-tube manometer as a function of the spatial position of a water reservoir. Using animation techniques the location of the reservoir can be "dragged" around the screen by means of the mouse, an Options Menu providing commands for setting parameters and taking readings. Meniscus levels visible on the simulated U-tube automatically adjust according to standard manometer equations. In another program, a Diving Bell descends from the surface of the ocean under the control of the student, permitting pressure measurements to be made anywhere inside or outside the bell, as a function of depth. Clicking the mouse causes depth/pressure values at the location of the cursor to be recorded on a data chart. Another experiment simulates a

Hydraulic Hoist in which parameters such as piston diameter can be varied to study their effect on the system. Finally a program is provided to analyze telemetered pressure/temperature/humidity data from actual Radiosonde Balloon runs. A chart of pressure vs height is formed, along with computation of the dew point. Menu options allow this information to be automatically plotted on command, or stored on disk.

Product Use, Evaluation, and Publication

Since the SP328 course is generally taught only in the Spring semester, it has not yet been possible to perform student tests on cT-based Fluid Physics products developed during the Summer and Fall of 1989. In the planned use of these programs, some will be performed in class, using a Mac computer with large screen, others will be assigned as homework problems, with instructions being provided on the steps required to perform an experiment on the simulated apparatus. A paper reporting on the project and describing the products has been submitted to the Winter Meeting of the American Association of Physics Teachers, to be presented 24 January 1990 in Atlanta, Georgia. The paper, entitled "Design of Simulated Lab Experiments for Student PC's, Using the cT Language and Environment," is part of a special session on the Integrated Use of Computers in Introductory Physics.

Long Term Objectives

It is planned to continue the development of exercises and simulated experiments for student use in the S328 course during the Spring of 1990. On account of its advanced user interface, and easy adaptability to many systems, the cT language is a very powerful tool for the development of direct instructional materials. Programs written for the Mac can, for example, be quickly translated into MS-DOS or UNIX programs, making them available to a wide variety of institutions. It is also possible to compose programs in MS-DOS and translate back to Mac. The initial effort has concentrated on development of courseware for a particular topic in the SP328 text--fluid statics. Eventually it is hoped to gather enough material to make up a supplementary computer courseware package, covering all chapters, to accompany the text *Fluid Physics for Oceanographers and Physicists.*

Statistical Computing in Applied Statistics Courses

Associate Professor Gary Fowler
Mathematics Department

Project Background

The goal of this project was to produce a computer package that would accomplish two objectives: (1) aid in the teaching and learning of statistics, and (2) provide the students with tools that can be applied to statistical problems encountered in their other classes and in the future naval service.

These objectives are at times inconsistent. The first requries calculations at a level of detail that is burdensome when analyzing data, but necessary when first learning statistics. The second frequently acts like a "black box" and inhibits insight necessary for understanding. On the other hand including too many details in accomplishing the first objective can detract from the statisticai methodology and understanding.

Instructional Development

Several methods of accomplishing the goal of this project have been tested. Initially the use of commercial statistical computer programs was rejected, largely due to their expense. Efforts were made to write the needed programs in house. In the midst of this effort funding for the Mathematics Department's network and the Academy's network became available, and these networks are mostly installed. These networks provide access by the midshipmen to large, expensive, and good statistical analysis systems.

The final solution is to use two commercial programs (SAS and MATLAB) and for the investigator to write a handbook illustrating and explaining their use. It has also been necessary to work out some problems involving communication over the two computer networks.

Product Use, Evaluation, and Publication

The program SAS and MATLAB have been used for two semesters in Applied Statistics I and II (SM339 and SA442). Writing and editing the handbook has been aided by the student's feedback. Many changes have been made and more changes are expected this semester and next semester (Spring and Fall 1990).

MATLAB is a programming package in which the basic units are matrices and vectors. These are more natural objects for statistics than are numbers. Many operations including means, variances and least squares are included and do not need to be programmed. Statistical analysis routines can be constructed from these internal procedures and stored for later use. The primary statistical feature missing from MATLAB are built-in functions for evaluating probability distributions.

Primarily MATLAB is a mechanism for accomplishing the first objective while SAS is the mechanism for accomplishing the second.

SAS is a large statistical analysis system. There is more overhead on the part of the students in learning SAS than MATLAB. Its value is that SAS is a well recognized and widely used system. SAS can be used as a command driven system or can be implemented by fill in the blank menus. It does not directly provide insight into statistical methodology, but does facilitate statistical analysis. Thus it indirectly provides insight by allowing realistic analysis to be performed by students.

The acceptance of MATLAB, SAS, and the handbook by the midshipmen has been excellent. They find both programs useful and helpful. They are especially impressed by the power of the first class statistical analysis system SAS.

It is planned that these computer programs will be used in Mathematics courses for many years and that the handbook will be expanded and improved. There is also interest from other departments and from the academic support group in Computer Services. Midshipmen and faculty in the Economics Department are using SAS. Several departments in the Engineering Division are using MATLAB. The investigator is working with the staff in Computer Services to remove bugs from the interface with SAS. The user interface with MATLAB needs to be upgraded to a full screen editor. Generally this project has been successful and will benefit from routine improvements and evaluation as it is used.

Development of Course Notes for EM471 - M.E. Experimentation

Professor John O. Geremia
Mechanical Engineering Department

Project Background

Experimentation is a broad field encompassing many disciplines and topics. From its inception, the EM471 course has been unable to rely on a single text that would provide the in-depth knowledge required by the philosophy of the course. That philosophy is to study a number of topics in-depth rather than to study many topics superficially. Past and current texts have chosen to prevent a multitude of topics but no general approach to planning and no detailed approach to signal validation. Consequently, a set of course notes was written in the 1970's and has been updated chapter by chapter over the last several years.

Instructional Development

This year the topic addressed was Fluid Flow Metering. Work on this has led to two chapters: Liquid Flow Metering and Gas Flow Metering. Emphasis has been placed on theoretical equation and their connection to databases, proper use, calibration and its role, installation, error sources and corrections for off-calibration use. The last topic is of considerable importance since the conditions of use are normally not the same as the condition of calibration.

Product Use, Evaluation, and Publication

The IDP will be used next semester as part of a new set of course notes for EM471.

Long Term Objectives

One objective shall be to continue to maintain the course notes up to date. In the Fluid Metering area, new data should soon be published by the National Institute of Standards and Technology on installation and correction coefficients.

Infinitesimal Modeling for Midshipmen

Professor Robert A. Herrmann
Mathematics Department

Project Background

This project is designed to create a series of training and teaching modules for faculty members of the mathematics and science departments as well as selected midshipmen. These modules are consistent with the technical level of the USNA faculty and will be disseminated either by printable freeware or in manual form. They present the sufficient and recently discovered rigorous methods and rules that utilize the calculus with the language of infinitesimals, as proposed originally by Abraham Robinson, to produce models for geometric and physical concepts. They are intended as a basis for the restructuring of the first two years of calculus and first year of physics and contain procedures to implement such a restructuring. These new procedures will make available to the midshipmen, for the first time, fixed sets of rules that are mathematically consistent and lead directly from a midshipman's intuitive classroom and laboratory experiences to the appropriate analytical (i.e. integral, differential equation) expressions that mirror geometric concepts or natural system processes. This new apprach, with its new methods and rules, will model rigorously the processes of infinitesimal reasoning and is designed to eliminate one of the weakest and most discouraging aspects of the first two years of calculus - the vague, nonspecific, inconsistent and confusing methods will greatly improve a midshipman's problem solving and application skills, and it will improve significantly the transfer of these skills to other areas of science and engineering.

In general, this new approach will entail simple alterations to the old infinitesimal terminology and will allow midshipmen to once again benefit from the highly intuitive processes of infinitesimal reasoning. By means of these rigorous procedures, they will better grasp and understand exactly why infinitesimal models are or are not appropriate and when appropriate why they predict natural system behavior. When fully implemented, this project will also allow midshipmen to derive, on their own and often without the aid of an instructor, all of the elementary integral and differential equation models utilized during their undergraduate education.

Instructional Development

Except for the basic calculus and the more advanced areas, there are no commercial textbooks nor any properly structured documentation available which presents modern infinitesimal modeling at the undergraduate level. For this project, the plan is to create teaching modules that will delineate to the faculty and midshipmen the methods of infinitesimal modeling. Even though these modules will be tailored to specific Naval Academy course content they will also be supplied, in limited quantities, to other federal institutions. The basic objectives are (1) the production of a Basic Manual with appropriate computer software detailing the fundamental rules and processes; (2) the production of the Physics Manual with appropriate computer software; and (3) the production of Engineering manuals with appropriate computer software. During each phase of production, seminars and discussions will be held with each targeted department in order to explain the purpose and methods, and to suggest appropriate implementation procedures. It is not intended that these materials be supplied to the faculty at government expense for an indefinite period. When the instructional advantages of this corrected approach have been amply demonstrated, then supplies of the modules will be limited to new faculty appointments. Certain civilian colleges and universities will also be supplied with the modules, at their expense, for evaluation and implementation purposes.

Since January 1989, the following aspects of this project have been completed. After various modifications, the final draft of the The Basic Manual comprising 266 pages has been completed. This final draft has been carefully examined and edited to insure correctness and readability. When funding is approved for project continuation, then the formal printing of The Basic Manual will be immediately instituted. Computer software has been created in order to transmit electronically this final draft to civilian colleges for evaluation purposes. The first rough draft (34 pages) of the Physics Manual has been prepared.

Product Use, Evaluation, and Publication

In April 1989, the first 8 chapters of the first rough draft of The Basic Manual were distributed to the faculty of the Mathematics Department. Certain members of the department have aided in correcting typographiccal errors in order to ensure that a quality product is produced. Since the final draft was not completed until August 1989 and not, as yet, formally printed direct use in a classroom setting has not as yet occurred. On 19 November 1989, the accomplishments of this project were discussed at the Howard University meeting of the Mathematical Association of America. Further discussions with members of the MAA are planned for April 1990. In order to achieve as rapid evaluation as possible, computer software containing printable files has been supplied to selected civilian institutions for immediate evaluation of The Basic Manual. This fall a dialogue with the Physics Department will be instituted in order to explain the purposes of The Basic Manual, The Physics Manual and to enlist their aid in implementing the project within their department.

Long Term Objectives

There is a long range project throughout the pure and applied mathematical community to restructure the foundations of modern mathematics to take advantage of the new discoveries in infinitesimal modeling. This is especially true in many areas of modern physics. Besides the discussed advantages to midshipmen, implementation and completion of this project will aid in preparing the faculty for this revolution - a revolution of which some faculty members are not aware. This should place the Naval Academy in the forefront of this scientific development and instructional change. It is anticipated that after this project has been fully implemented that the Naval Academy, in the long term, will become internationally recognized as a major contributor to this educational change as well as a leader in the mathematical development of these rigorous infinitesimal modeling techniques.

Indexing of the Maryland Gazette

Professor John W. Huston
History Department

Project Background

The newspaper in Colonial America was the only feasible means of organized communication and remains among the most valuable resources with which to study the past. Only ten newspapers were published with significant longevity in the period prior to and covering the American Revolution, providing scholars with an opportunity to assess the society of at least two generations of Americans in this critical period. Yet usage of these newspapers has been hampered by the fact that only one of these ten journals has been indexed and this index, although printed and available for scholars, is not computerized. The computerization of a newspaper is long overdue and the Colonial-American Revolutionary period seems an excellent place to begin, particularly with the emphasis on quantification which has marked methodological change in the historical profession within the last twenty-five years. The proposal was funded with IDP funds during the intersessional periods of 1988 and 1989, although work on the project has continued throughout the academic years.

Instructional Development

The aim of this long-range, comprehensive project has been to computerize the newspaper during the period 1745-1775. During the intersessional period of 1988 delays beyond the control of the researcher and the History Department hindered the selection of software. Much of the academic year 1988-1989 was spent in testing the software which was purchased, validating it against the categories selected and modifying those categories as more newspaper entries were identified. Particularly beginning with the onset of the French and Indian War, colonial interests appeared to focus more on intercolonial matters as contrasted with previous intracolonial concerns. Decisions were made that would make the index most useful for research in Colonial American affairs with only limited categories covering European events.

Midshipmen were encouraged in courses in American Colonial History, American Revolutionary History and the Honors Seminar to utilize the *Maryland Gazette* to write and complete required term papers. Among the kinds of research papers which the students accomplished was one that collected the data from ships clearing into and out of the Port of Annapolis, using data such as their point of origin, point of destination and time spent in port. Additionally it was possible to use the advertisements of those ships' Captains that appeared in the *Gazette* to learn something of their cargoes.

New lectures were able to be devised for the classroom based on the data gleaned from the indexing, thus bringing into clearer focus for the midshipmen events which happened in Annapolis in this period. Discussion was enhanced when the bulk of students were able to utilize data gained from their use of the index.

Product Use, Evaluation and Publication

Evaluation of the index has been and will be accomplished by the research papers which have been produced and will be produced from the index, as well as the enhancement of the classroom via lecture and discussion as result of use of the index. Further, when the index is completed, its publication for use by the scholarly community will provide further evaluation of its worth.

Long Term Objective

The long range objective is for publication of the complete index by a commercial or nonprofit press and being made available for widespread use by students and researchers.

Computer Aided Instruction in Logic

Professor David E. Johnson
History Department

Project Background

The objectives of this project were to procure and implement logic software for the philosophy courses at the Naval Academy. The purpose was to acquire software that would assist the midshipmen in learning some basic features of logic outside of class time using their own PC's.

Instructional Development

To facilitate the project the researcher attended the Fourth Annual Conference on Philosophy and Computers at Carnegie Mellon University in August 1989. For the needs of this project it was unfortunate that this year's conference was held in August. The investigator did not have time to follow up on leads he received of people who are working in this field (but who were not at the conference) in time to place orders during FY89.

Product Use, Evaluation, and Publication

The researcher joined the Anne Arundel County Board of Education Mentorship program, utilizing a local high school student to evaluate specific logic software. A student from Meade High School, named Scott Saxman, worked informally with the researcher during the summer and planned to work with him for credit during the entire 1989-1990 academic year as part of a mentorship program in the county school system. The investigator's plan was to have Mr. Saxman test programs on the computer from the user's point-of-view. Mr. Saxman spent part of the summer becoming familiar with rudiments of the notation of formal logic in order to be able to work comfortably with both informal and formal logic software. Unfortunately, about half way through the fall semester he decided that he was too busy with high school activities to devote any more time to this project. Therefore, the student evaluation of new programs did not continue. The investigator spent part of the fall term evaluating logic software without the help of a student intern, and has identified a couple of programs that will both be used in his classes and recommend to a new colleague in philosophy to be hired beginning in the fall 1990.

Long Term Objectives

The researcher will not be using any logic software prior to the spring 1991 term because his sabbatical will be during the fall 1990 term. Upon return from sabbatical the researcher plans to introduce one of the programs referred to in the previous paragraph. Support from the IDAC for this project has enabled the researcher to make the results of his research applicable to the philosophy courses at the Naval Academy. The investigator applauds the administration for providing this kind of support for the classroom teacher, thereby enhancing the quality of education provided by the Naval Academy.

Elements of Reliability and Maintainability in Engineering Design and Operation

Professor Eugene L. Keating
Mechanical Engineering Department

Project Background

The impact of the modern high speed PC-based data acquisition system and its capabilities for use within engineering curriculum is becoming clear. Specific hardware and software are now available to help accelerate learning and practice relevant to a variety of classical subjects. This project adopted PC data acquisition and analysis to a terminology of reliability and maintainability. A PC package and software package have been developed around a Petter's single cylinder diesel engine which can support R&M education. This new engine-PC system integrates fundamentals of fluid mechanics, heat transfer, thermodynamics, combustion, and vibration in a single entity. Such an interactive device allows real operating internal combustion engine data to be gathered, and translated into useful information which can then be used to teach fundamentals of operating power equipment with regard to R&M.

Instructional Development

Two student projects have been implemented to develop the specifics of this system for use in the curriculum: Development of Procedures for the Use of the ECA 872 Engine Cycle Analysis, and Diesel Engine Analysis Using Computer Technology. These two specific tasks, being prepared for formal presentation by the end of the semester, have allowed particular projects in engine maintainability to support both David Taylor Research Center interests as well as Mechanical Engineering VJEP students at the University of Maryland. Mr. Rolfe Munche at DTRC and Professor Ashwanee Gupta at the University of Maryland, are participating in the program. The ECA Engine Analyzer Package allows pressure vs. crank angle data to be gathered every 0.1 degrees of crank angle at 8000 rpm and up to 50 cycles. The package then reduces the data into information on engine health and condition by presenting eleven differnt combustion chamber functions, see figure 1. This information can then be used to make decisions with respect to the operation characteristics of the engine.

Product Use, Evaluation, and Publication

Application of the ECA system in the Mechanical Engineering program has already begun. Three specific laboratory experiments have been developed this year for use in EM320 Applied Thermodynamics and EM461 Combustion. The researcher was invited to discuss the use of this facility at the 1989 Advanced Engine Technology Conference in Colorado Springs, Colorado (4-7 December 1989). The keynote talk "Engine Cycle Analysis: The Next Frontier," introduced to over two hundred eminent engineers and educators in IC Engine technology the power of this PC-based engine interface in both engine design and operation.

Long Term Objectives

Research efforts between the University of Maryland, U.S. Navy Research Laboratories, and academic developments at the Naval Academy will be developed and expanded upon using this facility. Two professional papers are being prepared based on this IDP project. Extensive use of VJEP and other graduate-level student research is now underway with additional applications of the system being pursued.

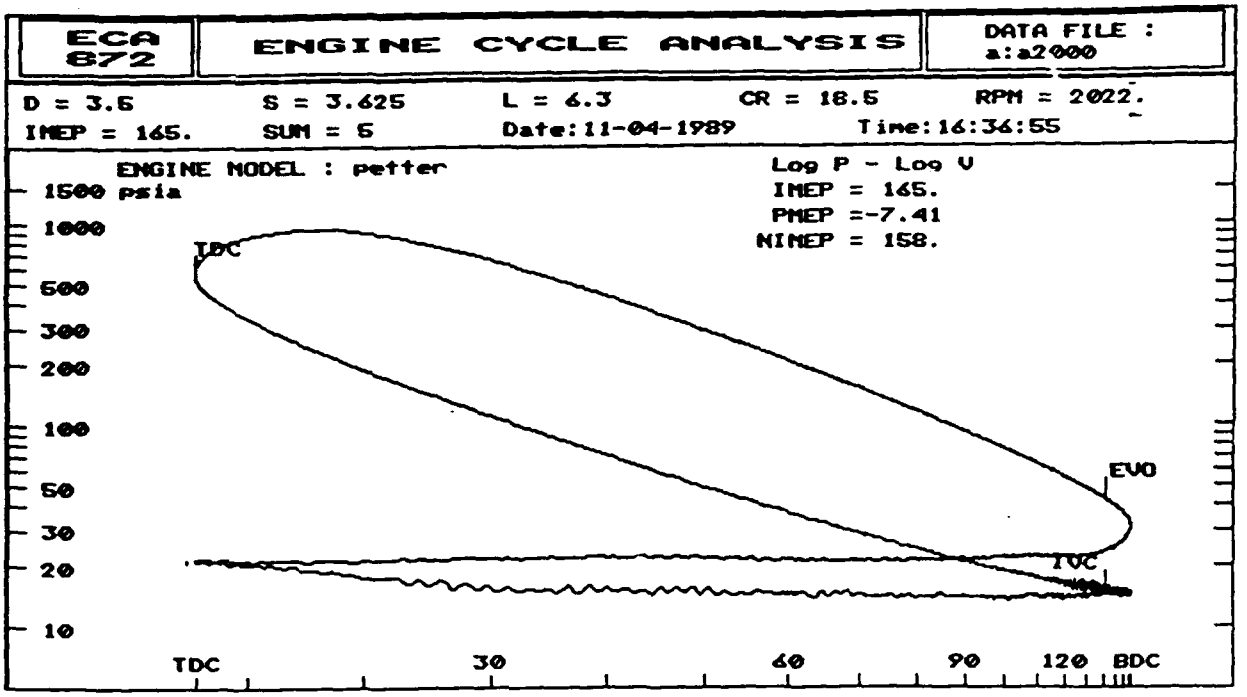

ECA 872
ENGINE CYCLE ANALYSIS
DATA FILE : a:a2000
D = 3.6
S = 3.625
L = 6.3
CR = 18.5
RPM = 2022.
IMEP = 165.
SUM = 5
Date:11-04-1989
Time:16:36:55
ENGINE MODEL : petter
Log P - Log V
IMEP = 165.
PMEP =-7.41
NIMEP = 158.
1500 psia
1000
500
300
200
100
50
30
20
10
IVC
EVO
IVC
TDC
30
60
90
120
BDC

Figure 1.

A Course in Tactical Environmental Support

Lieutenant Commander Richard G. Kelley, Jr., USN
Oceanography Department

Project Background

The course concept was to teach a combination of oceanographic theory and application to soon-to-be-commissioned Naval Officers. A computer system exists which would aid teaching applications. This system, the Tactical Environmental Support System (TESS) is currently in use in the Fleet.

Instructional Development

The plan for course development centered around the following events:

a. Procuring scientific and applied reference material,

b. Becoming familiar with TESS capabilities by visiting a TESS site,

c. Developing a course outline,

d. Procuring TESS software and any additional hardware not currently owned by the Oceanography Department, and

e. Drafting lesson plans.

Items a, b, and c have been completed.

TESS uses a classified database. This fact led to two course development options: converting TESS to unclassified use or using a classified system on campus.

a. Converting to unclassified use--Contact with Naval Eastern Oceanography Center and Geophysical Technical Readiness Laboratory (Monterey, California) indicated there are no existing, unclassified databases. Development of an unclassified database would be beyond the scope of the project, considering time and money (no cost IDP).

b. Using classified system on campus--Such an operation requires physical and electronic security. Physical Security--access to the machine and after-hour storage of the disks must be controlled. The researcher identified a space to control machine access and a vault to store the disks. The machine could be installed in the inner room of the Michelson Meteorology Laboratory; this space has easily controlled accesses and no windows. The vault is nearby, just one floor above the Meteorology Lab. Electronic Security--Electromagnetic emissions of the device must meet existing standards. The researcher contacted the Naval Academy Security Office for assistance. Other organizations (Naval Intelligence Command and National Security Agency) assist with approval of computers for electronic security as part of the TEMPEST program. It was learned from the Security Office that there were no approved, classified computing sites on campus, therefore these agencies needed to be contacted.

Long Term Objective

This is the point at which this project remains. Due to the electronic security problem the project will not be continued.

Development of Robotic Systems Laboratory Software

Professor Kenneth A. Knowles
Weapons and Systems Engineering Department

Project Background

The Robotics Laboratory of the Weapons and Systems Engineering Department provides the primary laboratory support for the course for systems engineering majors, ES451 (formerly ES485), *Introduction to Robotic Systems*, and the new course for non-systems engineers and technical majors, ES486A, *Robotic System Fundamentals*. It also provides the primary support for the systems engineering project design course, ES402R, *Systems Engineering Design (Robotics)*. The laboratory previously contained antiquated Zenith Z-100 microcomputers, aging open-loop control Microbot teaching robots, and a partial set of MicronEye Bullet elementary vision systems. The laboratory was updated this past summer to consist of twelve Zenith Z-248 microcomputers, twelve closed-loop DC servomotor Heath-Zenith teaching robots, and several dot matrix printers. The primitive MicronEye Bullet vision systems previously used were scheduled to be replaced by upgraded, but still primitive, MicronEye Idetix vision systems. Preliminary investigation carried out as part of this Instructional Development Project revealed the substantial superiority of a relatively low-cost computer vision system consisting of an external video monitor, a camera, and a Beeco FG-B100 frame-grabber card. As a result of these findings, the decision was made to equip the teaching facility with six of these units instead of the Idetix units. Eight more of these units were added to the teaching facility at the end of the Fall semester. In addition to the equipment previously mentioned, two Puma industrial robots, a Microvax II computer system, and a high resolution vision system have been installed in an advanced teaching/research facility.

With the exception of some control software which had been supplied with the Puma robots and the single high resolution vision system installed in the Microvax II, all the control and processing software for the teaching and advanced teaching/research robot facilities had to be developed locally. Virtually none of the previously developed software could be utilized with the new systems. As a result, a considerable amount of familiarization, systems integration, software development, hardware and software debugging, and laboratory development had to be done in order for the laboratory to be operational for the Fall 1989 ES451 course.

Instructional Development

The original problem proposed was to develop control and processing software to operate on Z-248 computer systems, operating under MS-DOS, to control the new closed-loop robot systems with this effort, several fundamental decisions had to be made concerning the computer language to use, and the manner in which the robots and vision systems were to be controlled.

The choice of an appropriate high-level language to be used by the robotics courses (ES451 and ES486A) was based upon a number of considerations: the language had to be easily assimilated by the midshipmen; site licenses were desirable; it must possess a fast execution speed (absolutely necessary when processing vision algorithms); it should have powerful input/output capabilities for communications and control; it should be structured and modular; and it should have a nice programming environment. After examining various PC versions of FORTRAN, Turbo C, Turbo Pascal, GW BASIC, QuickBASIC, and True BASIC, the latter was chosen as the language to be utilized. Subsequent faculty program development and student use during the course of the Fall semester has indicated that the choice of True BASIC was very appropriate.

The new Heath robots contain an internal PROM BASIC, which normally controls the robot motions. This BASIC can be activated by either the teach pendant control, or by a dumb terminal (or a computer operating as a dumb terminal, using a communications program). Just communicating with the robot from an external computer required some research before a suitable communications

program could be located. After testing numerous communications programs, a freeware communications program ("Pibterm") was determined to be satisfactory for dumb terminal operations with the robot, and for program transfers to and from the computer disks for permanent program storage. This configuration (robot operating under PROM BASIC, controlled from a computer operating as a dumb terminal) would be satisfactory for single stand-alone robot operations, but would not be satisfactory in an integrated work cell environment. It was determined that the Heath Factory engineers had no knowledge of how to control one or more robots from a supervisory computer within an integrated work cell environment. Research efforts subsequently determined that the robot could be externally controlled in the "direct" (or "command") mode, after bringing up the PROM BASIC, with the external computer issuing movement commands via the high-speed serial port (OCM1). This arrangement permitted an external computer, executing any high-level language program, to interface with the vision system, other robots, and other external sensors, and then issue appropriate robot commands based upon the information obtained from these sensors.

The ECHO single board speech synthesizer has been satisfactorily tested in conjunction with the True BASIC/robot/vision system. This board comes with a "load-and-stay-resident" program which permits easy generation of audio responses from the controlling True BASIC program. It is planned that these boards be installed in all of the robotic's teaching laboratory robots.

In addition to "shaking-out" the new equipment for the Weapons and Systems Engineering Department Robotics Teaching Laboratory facility, numerous True Basic programs and routines (subroutines, functions, libraries) have been developed to date. These have been blended into the laboratory exercises for the course.

Product Use, Evaluation, and Publication

The suite of new equipment assembled during this project works well together in the Z-248 computer, and each is one of the lowest cost of the devices with similar functionality. It is felt that this combination represents a near optimal arrangement for an undergraduate introductory robotics laboratory. The only apparent improvement that could be made would be to get a more powerful (80386 or 80846 processor) computer to speed up the computationally intense and relatively slow image enhancement algorithms. A paper describing the USNA Systems Engineering Robotics Teaching Laboratory facility and the introductory course (ES451) curriculum, is in preparation.

Long Term Objectives

There are two major long term objectives for the current instructional development effort. The first is to develop sufficient self-contained routines and laboratory exercises to support a proposed interdisciplinary introductory robotics course to be co-taught with a professor in the History Department to non-engineers. The extensive materials for this course cannot be prepared adequately, however, unless support can be found to permit the development work to be done during the upcoming summer intersessional period. The second major long term objective is to develop software and devise laboratory exercises to support a proposed follow-on course devoted to computer vision and pattern recognition.

Computer Use in the Thermal Sciences and Strength of Materials

Professor Vincent J. Lopardo
Mechanical Engineering Department

Project Background

Upon completion of fundamental courses in thermodynamics, the engineering student is often asked to make design decisions which require his ability to perform parametric studies of various systems. One of these systems is the gas turbine cycle which can be configured in a number of ways. Phase I of this IDP was to refine the author's previously developed program on the Brayton Cycle and to broaden its scope of applications for PC usage.

Another important area of interest for engineers is the design and/or analysis of new and modified steam power plants. There is presently software available which is modular in nature and advertises that it allows the user to model and analyze complex plants. Phase II of this IDP was to develop laboratory exercises which will take advantage of this new tool.

The third topic involved the use of some specialized software in strength of materials. The department had software which we had not been able to use in addition to some new programs which had not been tested. These all had to be evaluated for possible inclusion in fundamental and applied courses.

Instructional Development

In Phase I the gas turbine analysis package which had been completed earlier by the author was refined and modified. The program is on disk and requires that the user have Tru-Basic on his P.C.

The computer program is capable of performing a parametric study of 6 air standard gas turbine cycles. The basic Brayton cycle is analyzed along with five modifications: with regeneration, reheat, 2-stage compression (intercooling), 2-stage compression and regeneration, 2-stage compression, and regeneration and reheat. The user friendly program first presents schematics of the above and then allows the user to analyze a cycle of his choice. Any one of a number of parameters may be varied at a given time.

Pressure ratio, turbine and compressor efficiencies, and regenerator effectiveness are some of the variable inputs which may be utilized. The program primarily determines the First Law "thermal efficiency" and presents the results in a tabular or graphical output mode.

In the second phase of this IDP the possible use of some published software was investigated. The major emphasis has been on "STEAMBAL." "STEAMBAL" performs heat balances for steam power plants. It can be used either to predict the performance of a new plant or help in the testing of existing plants. It is also advertised as being effective in evaluating plant modifications. The rogram is modular in nature to allow the user to model and analyze complex plants. There are 15 standard modules available which can be strung together to create a plant of your choice. Documentation is provided and 1000 lines of programming space is made available in the program for personalizing it.

After some initial setbacks, subsequent plant configurations which stayed within strict confines worked well and the results compared favorably with alternate solutions. As the program now exists, there are a number of combinations which can be used in our applied thermodynamics courses.

The possibility of using "STEAMBAL" for an exergy or second law analysis was then investigated. This approach requires entropy at all stations and it was quickly determined that no saturated liquid entropy values were available in the program as presently written. To obtain their values an algorithm was obtained by (1) using the "curvefit" routine on saturated liquid data and (2) by using "TECHGRAPH PAD" on the same data. The second degree polynomial form "TECHGRAPH PAD" resulted in the best fit and was inserted into the program. It was then modified to output entropy and exergy rate as well as the usual parameters. A plant with one stage of regeneration was chosen for this study and the results form the basis of a major experiment in EM320.

Two other pieces of software were investigated - both from the author's other area of interest - Strength of Materials/Structures. A program which outputs Mohr's Circle along with principle stresses and strains had been obtained but had never been utilized. A comparison between the disk listing of the program and the documentation received showed a number of differences. The disk was then corrected by ECSP personnel to conform with the published program. Testing of the program was then satisfactorily completed by checking a number of problems. Its main feature is that in addition to solving a particular problem it allows the user to also rotate the element. The program produces the

following results: (1) Mohr's Circle, (2) Principle Stresses, (3) Principle Strains, and (4) Max. Shear Stress.

Another set of software for structural analysis came from the Civil Engineering Lab and appears to have great promise on the analyses of trusses and frames. However, the program for continuous beams was evaluated and found to be rather cumbersome. The program "QBEAM" which the author recommended as part of last summer's work appears to be far superior to the CEL and CADIG beam programs.

Product Use, Evaluation, and Publication

In addition to EM320 (Applied Thermodynamics) and EM217 (Strength of Materials), the programs will be useful in numerous other courses in which steam power plant analyses, gas turbines, and biaxial stress distribution are taught. A paper is being prepared on the use of "STEAMBAL" in applied thermodynamics courses.

Long Term Objective

It is the author's intent to continue his investigation of these programs for inclusion in our required and elective courses. It is recommended that correspondence with other schools be encouraged in order to take advantage of similar projects. An excellent vehicle for this type of interchange is the annual poster session sponsored by the mechanical engineering division of ASEE.

Computer Programs for the Calculus Classroom

Professor C. Edward Moore
Mathematics Department

Project Background

Over the past ten or fifteen years the author has been developing short simplistic computer programs that illustrate the basic concepts that arise in calculus. It is the contention of the author that the rote memorization that is foisted on plebes by "the system" is not the way to learn calculus, and that some way should be found to force the plebes to deal with the underlying ideas. The optimal solution would be for the plebes to solve some sophisticated applied problems by writing their own programs in the language of choice, whatever that is. Reality is a long way from that optimal solution--and especially in SM101-102, slow-track Calculus I and II. Three or four in a class of twenty seem to be computer-competent. Most have been exposed to some form of BASIC. It seems unlikely that any could write a program in Pascal that would solve a calculus problem.

Instructional Development

It was proposed that short programs be written in True BASIC™ that illustrate a concept or procedure and that the midshipmen be required to make small alterations in the programs in order to find solutions to related problems. The language True BASIC™ was chosen because of its: (1) similarity to BASIC8 on NATS; (2) ease of use; (3) structure; (4) short learning curve and consequent accessibility to first-semester plebes; and (5) excellent graphics capabilities.

Produce Use, Evaluation, and Publication

Thirteen computer assignments were included in the SM101, slow-track Calculus I, in the fall semester. It was arranged that True BASIC™ be issued on each plebe's computer, but a major error by the department computer representative allowed its omission. Frankly, it took a lot of time, effort, and diskette swapping to get True BASIC™ to each of the 350 plebes in the course. A document introducing the fundamentals of the language was written and distributed. Also a list of most of the commands and structures was given to each student.

As was to be expected, there was some start-up inertia and some expressions of computer phobia could be detected. It was necessary to provide extremely clear directions at first, and the work submitted was often off the mark. This was reasonable because most had not had SI180 and had had little computer exposure. But by the end of the semester almost everyone could do the assignments without much help.

Comments and answers to the researcher's questions in class have allowed him to conclude that there was considerable benefit derived from the computer experience of SM101. When a student was struggling with a calculus procedure that was illustrated in a program, the researcher found that their "light bulb would go on" when they went step by step through that program. Or, when reviewing a procedure they would ask if that is why the program simply drew the graphs of a function, its derivative, and its second derivative. By analyzing how the zeroes of the derivative led to potential maxima and minima of the function, it became much easier for them to relate to the material. It is different for the struggling student to determine which function should be integrated when solving volume of revolution problems. The program which follows shows clearly that a function named "disk" is the one being integrated, while "f(x)" is the original function.

Programs for SM102 are not yet available and their future is in jeopardy. It is inappropriate to publish anything on this approach until the second semester material can be included.

```
! DISK1      Volume of revolution by disk method,
!           using the Trapezoidal Rule
DEF F(x) = sin(x*x)            !define the function
DEF disk (x) = pi*f(x)*f(x)
PRINT "input n ";
INPUT n
LET a = 0                      !left endpoint
LET b = sqr(pi)                !right endpoint
LET h = (b-a)/n
LET s = disk(a) + disk(b)/2    !endpoint values
FOR i = 1 to n-1
   LET s = s + disk(a+i*h)     ! x1, x2, etc
NEXT i
LET Volume = s*h
PRINT "Volume =  ";Volume
END
```

Long Term Objectives

The approach taken in the first term of calculus should be extended to the other two terms of calculus and to differential equations. The researcher is convinced that short simplistic programs that illustrate the concepts can be of greater pedogogical value than programs with "bells and whistles." And the student who is most likely to benefit from this method is the "slow track" midshipman.

Update Physics Lab Software

Professor David A. Nordling
Physics Department

Project Background

In 1982 the Physics Department decided to incorporate microcomputers in all Physics Laboratories. The intended purpose for putting microcomputers in the laboratory was to enhance the midshipmen laboratory experience. It was felt that this would be accomplished by using the microcomputer to gather and analyze data.

In the fall of 1983, 70 microcomputer workstations were installed in all Physics Laboratories. The equipment associated with each Physics Laboratory workstation consisted of: (1) Apple IIe microcomputer with 128K of memory, (2) Analog to Digital interface, (3) One 5.25 inch floppy disk drive, (4) Dot Matrix hard copy output. Since January 1983, a considerable amount of software has been written to accommodate this workstation. As of January 1988 the software written required several (six) 5.25 inch floppy disks. It became obvious the system was somewhat handicapped by the limited memory and small capacity of a single 5.25 inch floppy disk. To reduce this handicap, several hardware enhancements which included a memory expansion to more than 1 Meg bytes of memory, a one 3.5 inch floppy disk drive and controller, and an accelerator board to make the CPU run 3.5 times faster were ordered. The 1 Meg memory expansion would allow all of the Physics Lab software to be loaded into RAM memory for fast recall and use. The 3.5 inch floppy disk has a capacity which is approximately 6.5 times the capacity of one 5.25 inch floppy disk. This will allow all of the software developed to be put on one (instead of six) floppy disk per workstation. The accelerator board was included to make all software run faster. These hardware enhancements were installed in all workstations in August 1989.

Instructional Development

All of the previously written software had to be revised to accommodate the hardware enhancements. As of this time (January 1990) approximately 80% of the software has been revised. A single 3.5 inch floppy disk has been prepared for each workstation. The title of the disk is Physics Utilities.

One of the very first things discovered was that in order for the system to function as planned, revision to the ROM in each computer would have to be done. The software for this revision was written and new ROM's were burned for each workstation.

A special operating system had been written to make use of the 1 Meg memory expansion. An error was discovered in this code and since has been corrected. Also, an extensive machine language routine was written to make saving and recalling data more user friendly. A routine was also written and incorporated into the Physics Utilities disk so that copies of the software can easily be made.

Product Use, Evaluation, and Publication

The revised software, Physics Utilities, has been in use in all Physics Laboratories since August 1989. The response from midshipmen has been very good. Casual observations seem to indicate that the midshipmen have little problems using the workstation to gather and analyze data. It is my belief that the current version of Physics Utilities is one of the best student lab interface systems available anywhere.

Long Term Objective

The original objectives were to use the microcomputer in midshipmen laboratories for the purpose of gathering and analyzing data. To this end a great deal of software has been written. The guiding principle in developing the software/hardware for the Physics Lab workstation is that it be no more than a tool for gathering and analyzing data by midshipmen in their laboratory experience. To take full advantage of this, the midshipmen must develop an understanding of the physical principles involved. For the most part this has been done. How well it is done depends to a large part of how well the software is written. As with most any creative efforts, this will require continued revision of existing software and writing new software.

Clearly at sometime in the future the current hardware (now approaching ten years in use) will be replaced with new hardware. Investigation into these potential changes and any necessary software and hardware preparations for such a change will have to be done.

Integration of an Equation-Solving Program into the First Course in the Electrical Engineering Major

Assistant Professor David Y. Northam
Electrical Engineering Department

Project Background

For the past few years, students in EE221 have purchased MathCAD for use in that course (the first course in the electrical engineering major). However its use was required in only a few applications and, as a result, the students made little use of the program. Because of the potential benefits of programs like MathCAD in technical courses, it was decided that a significant effort should be made to integrate a required use of the program in the early circuit courses, especially EE221.

Of the possible equation solvers, MathCAD was chosen because it is arguably one of the best and Addison-Wesley produces a low-cost student version. In addition, several instructors are beginning to use MathCAD in EE-major courses that follow the circuits courses.

The guiding philosophy for this work has been that any computer program, if it is to be of genuine value in the course, should become a tool that aids problem solving, theoretical and measured-data analyses, and/or reporting. It should be used by the student in the same spirit as the calculator is: there are problems for which the calculator provides useful support in solving and there are problems for which the same can be said of an equation-solver program.

It is assumed that incoming third-class students have a working knowledge of their personal computers and, hence, are capable of installing and using such an application program on their own.

Instructional Development

The approach taken in this project is to require the use of MathCAD in the EE221-laboratory preliminary problems, exercises, and reports. The first laboratory exercise of the course was written to require that the students perform the first tutorial exercise in their manual and that they generate tables and graphs of data as part of the preliminary problems. Therefore this first exercise requires, indirectly, that they learn the fundamental operations of equation solving, data tabulation, graphing, printing, etc. The follow-up laboratories were developed or rewritten (from existing exercises) to incorporate problems that support the laboratory exercise while having solutions that benefit from the use of MathCAD in an unobtrusive manner. (For example, graphical explorations of waveforms that were observed in the laboratory and graphical explorations of the concept of sampling.)

Product Use, Evaluation, and Publication

Thirteen laboratory exercises were developed or modified for use in EE221. They were used in 1989, fall semester. Effectiveness of the the effort was evaluated during the semester using discussions with students and grading of laboratory work and at the end of the semester a special course-evaluation questionnaire was used. (The questionnaire contained the same MathCAD-related questions as one used at the end of EE221 in the fall of 1988.) At least two general conclusions can be made regarding the new exercises. First, the program was used much more by the students in 1989 than in 1988, and, as a result, their proficiency in its use significantly increased. Second, a much larger proportion of the 1989 class than of the 1988 class gained an appreciation for the value of the equation-solver type of program. It is interesting to note that on occasion in 1989, a homework problem was completed with the aid of MathCAD (typically to "sketch the response").

It is anticipated that the various aspects of this work will be reported in ASEE conferences and/or publications and that a paper addressing the philosophical issues associated with the teaching of an introductory course in engineering will be prepared for the IEEE Transactions on Education.

Long Term Objective

It is anticipated that a continuing effort to further integrate the use of MathCAD into EE221 and EE232 (the follow-on course) will continue with each offering of the course.

Microcomputer Support for Core Calculus Course

Professors Howard L. Penn and Craig K. Bailey
Mathematics Department

Project Background

Pressure for changes in the core calculus program comes from a couple of different sources. First in the mathematics community as a whole there is a drive to reform the teaching of calculus; to make it "Lean and Lively" and to make use of the technology that is now available. Second, here at the Naval Academy there is a drive to use the computers that have been issued to the midshipmen in all of the core courses. Furthermore, every instructor has a computer and every classroom used by the mathematics department is equipped with a computer. These factors put the mathematics department in an ideal position to implement the use of the computers in the teaching of calculus.

Instructional Development

The development for this project consists of two portions. The first is a locally developed computer program, MPP, for the teaching of calculus. The second development is a collection of assignments which make use of the computer program and a couple of other programs that have been site licensed. The goals of this project include an increased emphasis on the concept of calculus and additional stress on the connection between the analytic and geometric representation of functions. There is also additional emphasis placed on the numeric ideas in calculus such as the use of Newton's method and Simpson's rule and on applications.

Product Use, Evaluation, and Publication

The assignments have been incorporated into the lesson assignment sheets for all three semesters of the standard calculus sequence, SM111, SM112, and SM211. The presence of these assignments has affected the type of questions asked on exams and the final. The students seem to have a better grasp of the concepts of calculus and feel more comfortable using the computer.

The program and assignments have received favorable attention in the mathematics community as a whole. Over 200 people have requested a copy of the program and problems. There have been a number of presentations and publications related to this project. In April, Howard L. Penn and Jim Buchanan conducted a minicourse at the sectional meeting of the Mathematical Association of America on MPP and a program that Jim Buchanan wrote for the teaching of Differential Equations, MDEP. This minicourse will be replaced at the national meeting of the American Society for Engineering Education. The researchers each made a presentation at the Joint Service Academy Conference on the Use of Computers in the Teaching of Mathematics. In August, Professor Penn made a presentation on MPP at the North Central Section of the Mathematical Association of America Workshop on Computer Graphics. In November, the two principal investigators made a presentation on computer generated spirographs at the sectional meeting of the Mathematical Association of America. The presentation was repeated at the national meeting in January. At that meeting, they also participated in a poster session on the calculus reform. Professor Penn had an article published in the College Mathematics Journal on software for the teaching of Mathematics. The two principal investigators have submitted for publication two papers, one on the calculus revision at the Naval Academy and the other on the Computer Generated Spirographs. Professor Penn, Professor Jim Buchanan, and Professor Thomas Mahar have submitted a paper on the use of computer graphics in the teaching of differential equations. The minicourse on MPP and MDEP will result in a publication in the Proceedings of the Meeting of the ASEE.

Long Term Objective

There are two objectives for the program MPP. First the researchers wish to add symbolic differentiation to the program and second they plan to add a module on the graphing of surfaces in 3-space. While there are many programs that will graph a surface in 3-space, none of these programs really graph what the students need, namely regions of integration for triple integrals. The researchers also wish to investigate the use of symbolic calculators such as HP28S. Since these calculators can compute derivatives and graph functions, their use should alter in a profound manner the way we teach calculus.

General Chemistry Laboratory Data Programs

Professor John W. Schultz
Chemistry Department

Project Background

The laboratory experiments in plebe chemistry commonly involve recording data and performing calculations based on the data. Graphing is frequently used to get the "best fit" of a set of values to a straight line. Some eight or nine such quantitative experiments are performed each of the two semesters of plebe chemistry. In the past, the chemistry department has employed programs in which the midshipman enters his experimental data and the data is sent to a file in the instructor's catalog. The instructor, at a later time, runs a program which performs all the calculations that are required of the midshipman. The program uses the midshipman's experimental data and prints out results that ideally should match those reported by the midshipman in his lab report. The printout is used by the instructor as an aid in grading the lab report and can be returned to the midshipman in order to assist him in understanding the material.

Instructional Development

During Spring Semester of 1987, the writing of a new series of computer programs was started. In these programs the midshipman is provided *immediate feedback* about the goodness of his data and calculations *at the time he enters his data* into the programs. This permits the midshipman to correct or redo his calculations before submitting his laboratory report for grading. Furthermore, this is done while the midshipman's interest in the experiment is still tweaked. Each experiment requires two distinct programs; one program is run by the midshipman and the other by the instructor. The programs are available in the L.SC*** chemistry sublibrary with filenames that correspond to the particular experiment. EXP13A would be the program which the midshipman runs for Experiment 13A. The program uses the midshipman's user number (alfa) to perform a lookup in another file. If the midshipman is registered for one of the plebe chemistry sections, his section number is determined. Experience has shown that midshipmen are very poor at remembering their section numbers and this lookup procedure is essential. Based on the section number, the program then performs a second lookup to determine the instructor's user number. Then a check is made to determine if the instructor has created a datafile to receive data from this program. If these conditions are met, the midshipman is informed that his data will be passed to his instructor. He is also given the opportunity to exit the program if he desires.

The computer takes the roll of "The Wiz" and the dialog includes a fair amount of humor. Much consideration was given to keeping the amount of data entry to a reasonable minimum. The intention is to encourage the midshipman to redo his calculations and reenter the information if appropriate. "The Wiz" may tell him his calculations are "out of the land of Oz" or "Toto must have chewed on his data sheet." Considerable amount of error checking is employed in the code so the midshipman can correct his data without having the program abort. Numerical values are checked for significant figures with reentry immediately requested if either the number of decimals or significant figures is incorrect. In checking the calculated values entered by the midshipman, feedback is of a qualitative nature ("right on" or "in the ball park but could be better"). Here again the purpose is to encourage the midshipman to redo the calculations and reenter the information if necessary.

For each experiment the instructor has a corresponding program to run (that is, EXP13ATB for Experiment 13A, TB standing for tabulate). In each case the program first asks the instructor if printouts of all runs by each midshipman are wanted, or if only the last one is desired. Other choices are whether hard copy or CRT output is desired, and if a summary listing is desired. The program then sorts the data by section and alfa and generates printouts.

In this project, programs were written for three experiments that did not have programs previously. Expecially noteworthy are the programs for Experiment 13A, Kinetics of H_2O_2-I^- Reactions. This experiment is more difficult than most for the plebes, and for the instructor difficult to grade conscientiously. It was also the most difficult of the experiments for which to write programs. During the writing, it became clear that the plebes would need guidance in the use of a spreadsheet for performing the necessary calculations. Consequently a spreadsheet template was generated which guides the midshipman into creating a resonable layout. In addition to writing the new programs, several others were updated and improved to make them more bomb proof.

Product Use, Evaluation, and Publication

At this time, 18 experiments have programs written for them. This virtually includes all of the quantitative experiments performed by plebes taking middle track chemistry. In the past year the programs were used by most of the plebe instructors. In general the programs have been well received by the midshipmen. Many have expressed their appreciation for being able to determine something about the correctness of their lab reports before the report is handed in for grading.

Long Term Objectives

The introduction of spreadsheets into plebe chemistry for the entire class in the fall of 1989 is something of a new direction for the chemistry course. This will result in many revisions and changes to the lab manual and the corresponding lab programs. The integration of these items will result in a learning process for the faculty as well as the midshipmen. This should improve instruction and provide additional opportunities for innovation.

User Aids for the Oxford English Dictionary on Compact Disc

Instructor Patricia P. Sine
English Department

Project Background

The library purchased the Oxford English Dictionary on Compact Disc to make available to midshipmen and faculty the resources of the most comprehensive dictionary of the English language. Unlike other disc programs, however, the OED on CD-Rom came with no useful user aids. The poorly written documentation provided by the publisher requires extensive study before searching can begin. The lack of aids for a system that is not user friendly meant that this expensive and useful teaching tool would be rarely used. The time it would take each user to figure out how to find and retrieve information would prevent most faculty and midshipmen from using this educational resource.

Instructional Development

Preparation of the user aids first involved the reviewing of the User's Guide produced by the publisher and working through the many facets of the compact disc program to discover its capabilities. Since the available documentation was difficult to follow and did not provide useful examples or commands in executable order, the researcher developed procedures and exercises. To support the investigation the researcher consulted with the librarians to determine their needs and the requests of those faculty and students using the OED. The researcher also reviewed user aids for other CD-Rom programs in the library to gain familiarity with user aid format. The writing itself involved outlining the capabilities of the program in a step-by-step manner, putting them together in manual form, and testing several drafts with librarians, faculty, and midshipmen.

Product Use, Evaluation, and Publication

The OED on CD-Rom User's Manual will enable students and faculty in many departments to make good use of this educational resource. Understanding words in their historical, geographical, and cultural contexts is important to students of English, history, economics, languages, and the sciences. Defining is certainly an essential strategy for all kinds of writing, and knowledge of words in all their nuances and historical fullness is essential to reading comprehension and written expression. Furthermore, specific knowledge of the capabilities of the system will enable faculty to design assignments encouraging students to explore such topics as usage, etymology, dialects, and quotations, and to make their own scholarly applications. The OED on CD-Rom User's Manual was tested for ease of use by midshipmen in English classes, by faculty in English and history, and by librarians. Their responses and comments provided valuable input in manuscript revisions.

Copies of the manual will be sent to faculty members in English and history and are available for student and faculty use in the library. The manual is also available for classroom use.

Long Term Objectives

The User's Manual to the OED on CD-Rom should provide the basic information necessary to operate the current program and future editions. Additional functions in future editions, however, may require a supplement to or editing of the current guide.

Development of Instructional Materials for SO441 Using the Computerized Meteorology Laboratory (Phase II: Implementation)

Associate Professor David R. Smith
Oceanography Department

Project Background

This project was originally designed for a two-year time period. Year One involved the development of twelve laboratory sessions for Synoptic Meteorology (SO441) to be utilized in a computerized environment. Year Two involved the implementation phase of these lessons as laboratory exercises for SO441.

The primary objective of the current phase of the project was to incorporate these instructional materials as Synoptic Meteorology exercises using the new computerized meteorology laboratory (MetLab). The lessons were designed to take full advantage of computer technology and to develop the students' skill in synthesizing and interpreting available meteorological information. In addition to implementing the lesson plans, Oceanography Department faculty members who teach meteorology courses were to be given instruction on the new computerized laboratory utilizing these lessons. Furthermore, the lessons were to be evaluated by SO441 students to determine their effectiveness in teaching Synoptic Meteorology.

Instructional Development

During the Spring Semester (1989) several new laboratory exercises were implemented into SO441. Since the computer hardware and applications software had not yet arrived, it was impossible to utilize the lessons as designed and to adapt them to handle details specific to the MetLab computer system. However, since the meteorological data products that were to be accessed by the computer system were available, SO441 students were able to perform the objectives of the lab exercises using conventional analysis techniques. This was a very successful simulation as the new exercises focused the students' attention on interpretation of the data and how it depicted the structure and behavior of the atmosphere.

Several other activities were accomplished to enhance the instructional development. In May 1989, the researcher attended the Hewlett-Packard course - "HP-UX for Programmers." This course will be quite important for file management, data backup and retrieval, and applications software implementation and development. In June 1989 the researcher visited personnel at the Computer Laboratory for Atmospheric Sciences at Purdue University to discuss current instruction of Synoptic Meteorology at that laboratory. In July and August the researcher reviewed materials presented at the Summer Workshop on the Use of Computers in Synoptic Meteorology, held during the summer of 1988. These materials were consistent with objectives stated for this project.

Product Use, Evaluation, and Publication

The laboratory exercises developed in this project have been introduced into SO441 during the Spring and Fall semesters (1988-1989 academic year), and used by three different course instructors. Full implementation, including modification of laboratory exercises to handle specific problems related to the hardware and software, will occur during the Spring (1990) semester, upon completion of software installation (now in progress).

Preliminary evaluations (without the computer environment) by Spring 1989 students in SO441 were quite positive. Evaluation of the laboratory exercises will be accomplished during the Spring (1990) offering of SO441 (2 sections with 23 students enrolled).

A paper entitled, "Developing a Computerized Meteorological Laboratory for Undergraduate Student Instruction," was presented at the Fifth International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology (ICIIPS), sponsored by the American Meteorological Society. This paper appeared in the preprint volume of that conference.

A second paper has been accepted for presentation at the Sixth ICIIPS Conference (February 1990 in Anaheim, California), and will appear in the preprint volume for that conference.

Long Term Objectives

Although the current project ends in January 1990, development and modification of the laboratory exercises will continue as experience with the computerized environment is acquired. Even though problems in procurement of the hardware and software required for full implementation has delayed completion of this project, progress has been made toward accomplishing its objectives. After the computer hardware and software have been completely installed, the project will continue with modification of the laboratory exercises, testing of the lessons on SO441 students, and evaluation of the effectiveness of the project on teaching synoptic meteorology to midshipmen. These laboratory exercises will be the basis for future instruction of Synoptic Meteorology and will become the model for incorporating computer learning into all meteorology courses in the Oceanography curriculum at the Naval Academy.

Introduction of Elastodynamics to Computer-Aided Mechanical Design

Professor Russell A. Smith
Mechanical Engineering Department

Project Background

This project developed instructional material on the behavior of elastic bodies in problems of rigid-body dynamics. The approach taken emphasizes the use of computer-aided engineering in design. The material has value in teaching basic engineering dynamics and vibration, in addition to the engineering design application.

Among the problems in dynamic analysis of machines, many occur when inertial loads create significant displacements in beam-like members and when natural frequencies in the component parts are excited by restoring or driving forces. The presence of beam-like members in these problems is common. The static behavior of such members is familiar to undergraduate students through experience in strength of materials. They are also familiar with the rigid body dynamics problem and elementary vibrations involving one and two lumped-masses. In elastodynamics these heretofore disparate topics are combined. The emphasis to the student is understanding the fundamentals of the elastic force system and the rigid body dynamics rather than mastering the theory using a continuous constitutive relation between strain and stress. Finally, the solution itself is facilitated by the use of a simulation computer code. In this work, the ADAMS (Automated Dynamics Analysis of Mechanical Systems) code was used; however, other similar codes would suffice. Lecture material, illustrative problems and design problems were developed and evaluated.

Instructional Development

Elastic behavior in rigid-body dynamics is accomplished by modeling an otherwise rigid body with a system of rigid subparts connected by force fields that are analogous to elastic springs. These elastic springs can include translational and rotational degrees of freedom measured by the relative displacement between adjacent "connected" bodies. Lecture material that is based on the student's understanding of beam internal actions (axial, shear, bending and twisting) was developed to explain the origin and form of the force field between the rigid subparts of a beam. Lecture material was also prepared to explain the solution approach taken in a complicated nonlinear dynamics problem. The actual solution was then left to the numerical execution of the computer code.

Three example problems were developed. Each problem can be easily modeled by the student, yet each problem illustrates important concepts. These problems extend the opportunity for the student to gain experience in modeling mechanical systems beyond rigid body problems. The problems were (1) bouncing ball, illustrating the generation of impact load with damping based on the deformation of the object, (2) accelerating cantilever beam, illustrating a distributed mass model of a beam and its vibration when placed in motion, and (3) impulsively loaded pinned-beam with damping, illustrating the distributed mass model and the results for shock loading.

Two substantial design problems were formed. One problem required the student to select a minimum weight rocker-arm in a valve lifter while maintaining prescribed tolerance limits on the valve seating and avoiding valve chatter from spring vibration. This problem was judged too ambitious for the three weeks available for execution, and a second design problem was formed. In this second problem, the member cross-sections of a high speed "picker" (four-bar) mechanism were designed for minimum weight subject to a limit on dynamic deflection of .002 inches.

Product Use, Evaluation, and Publication

Changes in design instruction in the Mechanical Engineering Department dictated the material be implemented in the new course, EM487 Computer-Aided-Design. This course was created by the department curriculum committee with the objective of giving unique attention to the use of computers in design. Moreover, an eight week period was allotted to the subject of mechanical system design.

In this eight week period students were exposed to exercises on the SUN 3/50 workstations that gave them a familiarity with the workstation and the local network through the use of three problems in rigid

body kinematics and dynamics. Then problems in elastic members were introduced. The eight week period was completed with a three week design problem for the elastic four-bar mechanism as noted before. A number of support items in the nature of course handouts were developed. These include subject matter on numerical analysis, dynamics, the SUN workstation and student exercises.

The course was offered to 15 senior-ME students. The students represented a cross-section of ability as measured by their CQPA, which ranged from 2.4 to 3.4. Student reaction to the course material was highly favorable. The opportunity to use computers and simulation codes that combined interactive data input, graphic simulation and plotting of results was an exciting experience. More important, the experience gave the student some insight into modern computer-aided-design as well as some experience in dynamic systems that would not be possible over the same time period of an analysis course. Although student reaction is encouraging to this instructor, it is felt strongly that future offering of this material should give more emphasis to lecture material and place more demands on student use of equipment outside of class and lab sessions. The compression of this material into an eight week period caused some lecture time to be sacrificed for the opportunity of hands-on experience. Future offering of the computer-aided-design course should devote the entire semester to ample opportunity for increased lecture time as well as increased opportunity for design problems.

Publication of experience in teaching these concepts is anticipated. A workshop on this material is scheduled for the Middle-Atlantic Section meeting of the American Society for Engineering Education on 28 April 1990.

Long Term Objective

The ultimate objective in implementing simulation programs like ADAMS for design instruction is to involve students in the use of modern interactive computing, and to solve problems that require modeling of physical principles rather than simply solving equations. To this end the Mechanical Engineering Department will begin the offering of a required course in this subject to the Class of 1991.

Configuring a Computerized Classroom\Laboratory for the Oceanography Department

Lieutenant Commander Gary L. Stringer, USN
Oceanography Department

Project Background

This project completes the configuration of a computerized meteorological laboratory which began the summer of 1987. Due to procurement delays resulting from purchasing freezes during the summer of 1988, the project as described in the IDP proposal of LCDR Coolbaugh (1988) did not proceed as quickly as anticipated. The delivery of software and hardware did not occur as anticipated on 1 January 1989. Hardware and applications software contracts were finally awarded 31 July 1989 to Hewlett-Packard, Inc. (HP) and 30 August 1989 to RMS Technologies, Inc. (RMS) respectively. The delivery of hardware is now complete and the applications software is being installed.

The state-of-the-art computer system ordered will be primarily used for midshipmen instruction. The system consists of seven networked HP-370 computers (4 student worksites, one instructor workstation, one faculty workstation/data ingest subsystem, and one data management subsystem). The system is located in Michelson Hall rooms 203 and 223. The system has the storage and processing capacity for the future addition of up to thirteen student worksites, each driven by its own HP-370 (HP-UX) operating system and enables digital image processing of remote sensing data, interactive graphic analysis and interpretation of raw and gridded environmental fields, display of radar data and many other functions required for environmental education in a classroom or laboratory climate. In short, the system will place the Academy at the forefront of computerized undergraduate meteorological and oceanographic study.

Instructional Development

In March 1989, the Hewlett Packard course "HP-UX for Programmers" was attended in Rockville, Maryland in order to gain knowledge on the operating system. In the spring, technical evaluations of proposals were completed and during the summer, the procurement process was monitored. The room sites where the system is set up were readied for system installation. Meteorological data ingest sources were also installed and are operational. After all hardware was received, HP engineers installed the computers, disc drives and operating system. RMS software programmers are currently installing the application software and will provide on-site operator training.

This instructional development project is planned to be completed in conjuction with an Instructional Development Project by Associate Professor David R. Smith of the Oceanography Department. A continual exchange of information between both project directors has kept the focus of this project on the proper development of the learning environment.

Product Use, Evaluation and Publication

System evaluation will begin as soon as the system is fully installed and operational, and after Associate Professor Smith and the researcher have received on-site training on its use. Initial faculty impressions of the system and applications software as it is being installed have been very favorable. The evaluation/testing will occur in four phases:

a. Course material developed for Synoptic Meteorology (SO441) per Associate Professor Smith's IDP will evaluate the systems functional characteristics.

b. The Oceanography Club will have several (10-20) students involved in real-time weather forecasting utilizing the system. The weather forecasts will be for various events at the Naval Academy.

c. The instruction of faculty members on the system's capabilities will provide the final testing grounds for the environment developed.

Associate Professor Smith and the researcher have submitted a paper for a presentation at the Sixth International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrography, sponsored by the American Meteorological Society. This paper, entitled "Computerizing the Meteorology Laboratory at the United States Naval Academy," has been accepted for presentation at the conference secheduled for February 1990 in Anaheim, California. The paper will appear in the Preprint Volume for that conference.

Long Term Objectives

Although this project formally ends in January 1990, the configuration of the learning environment will continue as experience with the application software is gained. Despite procurement delays progress has been made towards accomplishing all objectives; and following complete software installation and training, the project will proceed with the tailoring and testing of the environment. Additional student and faculty workstations will also be installed as funding allows. This configuration of the computerized meteorological laboratory will be a model for the computerization of other Oceanography Department laboratories and classrooms.

Updating the Naval History Slide Collection

Associate Professor Jack Sweetman
History Department

Project Background

The purpose of this project was to enrich the Naval History Slide Collection used to support HH204 (American Naval Heritage), an element of the core curriculum, by the addition of slides pertaining to naval history since World War II and the preparation of a user's guide describing the subject of each slide and explaining its historical relevance.

The Naval History Slide Collection has long been a valuable teaching tool for HH204 and its predecessors. Until now, however, the collection's coverage effectively ended with World War II. This project was designed to increase its usefulness as an instructional aid by bringing it more up to date. Any discussion of the history of the Brown Water Navy in Vietnam, for example, must benefit greatly from an instructor's ability to illustrate the variety of small combatants of which is was composed. The adage that "A picture is worth a thousand words" is never more apposite than in regard to naval technology, which, because of its influence on the conduct of operations, is necessarily an important ingredient of HH204.

Instructional Development

In accordance with the aims outlined above, a collection of 146 slides of postwar naval subjects (ships, aircraft, weapons, individuals, operations, etc.) has been assembled and a 32-page user's guide compiled. The collection begins with a set of 29 slides surveying the development of naval technology since 1945. Succeeding sets illustrate the Navy's operational history in a chronological progression from the battleship MISSOURI'S visits to Greece and Turkey in 1946, an early instance of Cold War naval diplomacy, through Operation Praying Mantis, the action fought in the Persian Gulf in the spring of 1988. Of these, the largest set (64 slides) relates to the Vietnam War.

For the convenience of the user, the guide includes indexes by slide number of ships and individuals as well as a topical table of contents. In addition, it provides a capsule history of recent events not covered by course texts--e.g., the Navy's involvement in the "Tanker War" in the Persian Gulf. The length of the annotations for individual or associate slides varies from one or two lines to substantial paragraphs. The following, sample entry, together with its sub-set heading, appears on page 15 of the user's guide:

OPERATION MARKET TIME

The Coastal Surveillance Force (TF115) was established in March 1965 to prevent maritime infiltration of enemy supplies on the coast of South Vietnam (Operation Market Time). This was the genesis of what became known as the Brown Water Navy. Responsibility for the operation was relinquished to the South Vietnamese Navy in September 1970.

57. A Swift boat in the Gulf of Thailand, March 1968. (Official US Navy Photo.)

The Swift boat or PCF--Patrol Craft, Fast--was the vessel selected to conduct Operation Market Time. It set a precedent for the Brown Water Navy by being a conversion of an existing craft, in its case a service boat for offshore oil rigs. Aluminum-hulled 50-footers, Swifts carried a crew of six and had a top speed of 23 knots. Standard armament consisted of a twin .50-cal machinegun forward and a single .50 piggybacked with an 81mm naval mortar, aft. A total of 84 Swifts were eventually deployed to Vietnam.

Product Use, Evaluation, and Publication

As noted, the product is intended to serve as a visual aid in classroom instruction in the American Naval Heritage core course. It is also relevant to HH384, the Recent Naval and Military History elective. The effectiveness of the program can best be evaluated by instructors on the basis of practical experience with and student response to it. Copies of the user's guide have been duplicated for the use of the History Department faculty. No further publications are contemplated.

Long Term Objectives

To enhance the instruction of midshipmen.

Video Disc - Video Presentations

Professors Larry V. Thompson and Philip W. Warken
History Department

Project Background

Building on the experience gained during the summer of 1988, six additional computer-video presentations have been created using the Virtual Video Producer. This integrated hardware/software system captures video images from any running source (disc, tape, camera or broadcast), creates custom graphics, overwrites titles and text, and transfers them to the computer.

Instructional Development

The new presentations, "The Great Depression," "Labor and Industry in the Nineteenth Century," "Labor and Industry at the Turn of the Century," "Flight," "Trench Warfare," and "Diplomats and Peace Conferences" are more sophisticated than previous ones. Greater mastery over the drawing and graphics software resulted in text that is more varied and of greater eye appeal and images are more imaginatively presented.

Product Use, Evaluation, and Publication

All of the new presentations were used in class during the fall term with considerable success. Because they are custom made, the presentations can be adapted to introduce or review specific parts of a course, focus on an ongoing theme or allow an instructor to introduce complicated material in an appealing way.

An article about the video presentations was published in *T.H.E. Journal*, December/January 1990.

Long Term Objectives

One of the great problems in creating classroom presentations has been the scarcity of images available for transfer to the computer. In our investigation into ways to remedy this situation, we discovered the Canon ZapShot. This computer peripheral captures images digitally, live or from pictures. The designers of Virtual Video Producer feel that it is compatible with their system. Therefore we have, with the support of the Director of Computer Services, ordered a ZapShot. It arrived recently and experimentation will begin shortly.

A work station for the creation of classroom presentations using the Virtual Video Producer has been set up in the History Department computer room. A users guide to help interested faculty master the work station will be available in the spring of 1990. The guide will become more useful to the extent that more classrooms are equipped for interactive video presentations.

Addendum: Video Disc Status Report

The video disc project has been stalled at the premastering stage, because of technical problems. The premastering system which ERC purchased for use in completing this project has proved inadequate to the task. The images it produces, when transferring slides to tape, is of inferior quality. In addition, because of the way it utilizes the tape, only 300 images can be placed on one side of a video disc. This is self-defeating, because the great advantage of laser-disc technology is that it provides instant, random access to many thousands of high-quality images on a single disc.

The Educational Resources Center is currently attempting to contact imaging laboratories, to see if an alternative procedure is physically and economically feasible. As part of the effort to solve the technical problems of the video disc project, ERC has accepted the offer of Professor Emeritus J.C. Thompson, founder of ERC, to assist in finding solutions. Two areas that offer potential solutions to current technical problems are a camera purchased by USNA Archives that converts slides to video tape which could then possibly be premastered here and/or the premastering could be done at Hill Air Force Base, Salt Lake City, Utah. The Air Force facility is state-of-the-art in configuration and

equipment. If necessary, the slides could be converted to tape there, subject to how they are delivered to the facility, technical problems involving sequencing of vertical-horizontal images and, most importantly, the overall cost. The researchers are currently pursuing both alternatives with a view toward compiling a precise cost estimate. With a cost estimate in hand, the researchers will then pursue funding availability for the completion of this project.

If the new approaches to the video disc project prove economically feasible, premastering could begin in the late spring and mastering would follow immediately.

Evaluation of Educational Software for English Teachers

Professor David O. Tomlinson and
Associate Professor Harriet F. Bergmann
English Department

Project Background

This is the final report on a two-year project. When the project began in 1988, academic software for teachers of English was just appearing on the market and on bulletin boards. Its appearance coincided with the delivery of computers to the entire English Department faculty. The researchers saw a threefold need: the software had to be purchased and tested, reported on, and made available to the department and to the faculty yard-wide.

Once the project was funded in 1988, the researchers began a search for software that could be of use in the writing, reading, and analyzing of text. They spent approximately $7,000 the first year and $5,000 the second year on software. In addition, a great deal of shareware was collected from bulletin boards, educational groups, and CompuServe.

Because funding was somewhat delayed in the first year, collection was a bit slow in starting; but when funding came through, all purchasing was accomplished.

During the first intersessional period of the project, the investigators tested style checkers and a number of miscellaneous programs such as literary terms programs, writing organizers, and grammar improvement programs. During the second intersessional period they concentrated on grading programs, outlining, and thinking programs, programs designed to enhance the prewriting protion of the writing process, graphics and desktop publishing and word processing enhancements.

Instructional Development

The researchers have been most concerned during the life of this project to make the results available to the faculty at large. To that end, they have held brown-bag lunches to report their findings and to demonstrate the uses of the software they have gathered. In addition, the researchers have tested the programs in two ways. They participated in the Mentorship program and had the student researchers test some programs for them. The investigators also used the programs in their Plebe English classes.

Now that the English Department has its own computer classrooms, it will be easier to make the programs available to teachers and students alike and thus to have the programs be true instructional tools.

Product Use, Evaluation, and Publication

The "product" of the grant is the software that was gathered. The importance of that product has come in the knowledge gained about the use of software in English and have been able to pass on to the faculty and colleagues in the region. These results have been made available in three different ways:

(1) The most important has been the education of the USNA faculty. Their new knowledge of what can be done with computers is testimony that the project was needed. The new demands by faculty for sophisticated software and the recent interest by a few in creating software are natural outgrowths of their interest.

(2) The investigators made the results of their research known outside the Yard as well. Style Checkers, a published report, was disseminated throughout the department, the Yard, and to members of the Middle Atlantic College English Association. Its distribution to over two dozen area electronic bulletin boards resulted in national recognition. The publisher of the top-rated program asked to reproduce the review of his product. He had received a copy of it from someone in Michigan who saw the reviews on an electronic bulletin board. The researchers wrote several short articles about programs they had discovered which people in other departments might want to use, and those articles were published in Computing at USNA. In addition, an article on style checkers resulting from the investigators' work appeared in Chips, a publication distributed worldwide within the naval community. "Help for the Writing Teacher: Analyzing the Writing Analyzers" has been accepted by the *Computer-Aided Composition Journal* and will be appearing in the Winter 1990 issue.

(3) Finally, the researchers have constructed a database so that the programs they have collected will be easily accessible to the faculty. The researchers are in the midst of putting all the programs collected into the database, a formidable task. The database, constructed in PC-File and exportable to D-Base, can be used by faculty outside the English Department. The programs themselves will be available for checkout from the English Department's Word Processing Room.

Long Term Objectives

The funding of this project shows the ability of the IDAC to respond to immediate needs. The project took the English Department from its weak position of knowing little about what resources were available for computer use in the fields of composition and introduction to literature to a position of strength. Many faculty members now know about some of the resources available and are beginning to use them. A few have even become knowledgeable enough to see where needed materials do not exist, and they are trying to create those materials using OOP (Object Oriented Program) techniques.

Faculty members who were just becoming aware of word processing two years ago have come up to speed in an astonishingly short time, and the results from this research project have helped them see how computers could be useful to them. They now understand that participation in the creation of software is the next step in satisfying their needs. The long term objectives of the project have been accomplished.

Annapolis Interactive Video Project: Satellite Telecasts and Computer-Assisted Language Acquisition

Associate Professor Sharon Dahlgren Voros and
Associate Professor William H. Fletcher
Language Studies Department

Project Background

The Annapolis Interactive Video Project has completed its second year of field testing computer-based language instruction materials in the curriculum. Since its first year of full-time development (1985-1986), the investigators and their colleagues have maintained a high level of productivity in computer IAV lessons for listening comprehension of native-speed materials, collected from international satellites and selected videodiscs. One special strength of this project has been its use of language professors as principal course designers to develop interactive video (IAV) instructional strategies for making authentic foreign video accessible to lower-level language learners. Midshipmen listen to language that is linguistically current and thematically appealing. Our efforts have attracted national and international attention through faculty presentations and publications.

International television is a revolutionary resource in foreign language instruction. Adapting authentic materials is especially necessary and time-consuming for the lower-level courses, which constitute over half our enrollments.

Instructional Development

For Summer of 1989, the investigators, the current Project Director, William H. Fletcher, and team member, Sharon Dahlgren Voros, 1985-1986 Project Director, collaborated to revise existing courseware for beginning and intermediate Spanish. As part of the formative evaluation, courseware critiques by midshipmen were reviewed carefully, to gauge both the effectiveness of instructional activities and the suitability of the video materials.

As coordinator for FS101-102, Associate Professor Sharon Dahlgren Voros reviewed and revised colleague-authored IAV courseware for beginning Spanish. Modifications included revising exercise and quiz items to conform with the authoring team's insights and students suggestions. At beginning levels fill-in items are more effective in exercises than in quizzes. This investigator implemented a greater variety of item types in quizzes than existed in the previous iteration of the courseware. She also assumed final editorial responsibility for computer-based grammar and vocabulary drills for these courses written by Assistant Professor Rita Landers.

As Project Director, Associate Professor William Howard Fletcher coordinated efforts of the nine colleagues active in IAV last summer and implemented several enhancements to the department's offerings in IAV. He reviewed and in some cases extensively rewrote existing lessons for FS201-202, and wrote three new lessons for FS102. He authored video quizzes for the weekly lessons based on BBC's *Zarabanda* course, which is shown to the control group in our longitudinal study of the effectiveness of IAV. He revamped and extended Cyrillic font support and completely reprogrammed the PLAYER program, used in Russian and upper-level Spanish courses. This investigator devoted much effort to evaluating and procuring hardware, software and imageware products which will enhance our laboratory's offering. He also authored an article on the project and a review of a videotape series for learning Spanish.

Product Use, Evaluation, and Publication

The courseware described above is used weekly in lower-level Spanish courses by 220 midshipmen; department-wide almost 450 midshipmen regularly use IAV. Formative evaluation based on learner polls and use data from existing lessons continues. Our team is also benefitting from critiques of lessons and pedagogical approach by Secretary of the Navy Fellow Janet Swaffar, a renowned scholar in the methodology of foreign language instruction using authentic materials. Progress toward the summative evaluation in our four-year longitudinal study of the effectiveness of interactive video is on target; the last generation of subjects enters FS201 in 1990, and results of this study will become available in 1991.

Our unique insights and contributions are being shared with the academic community through various prominent channels. Articles featuring the project will appear this year in *Hispania*, *Association of Departments of Foreign Languages Bulletin* and conference proceedings; already five conference presentations are scheduled for 1990. The project's software has been submitted for two national awards. A selection of our courseware is displayed at the National Demonstration Laboratory for Interactive Educational Technologies at the Smithsonian Institution; other awards and public fora are being investigated. Finally, a steady stream of inquiries from other institutions results in frequent visits to our installation (over 450 visitors in 1989).

Long Term Objectives

The Language Studies Department intends to implement similar IAV courseware for all languages and levels taught. The investigators have conditionally been awarded IDP support for summer 1990 to develop IAV courseware for French, German and upper-level Spanish. Additional outside funding for software development for Chinese and Japanese is expected. Work on extension of IAV to computer-adaptive language testing continues as time permits. Planning is taking place and funding is being sought for further research into the relative effectiveness of pedagogical and presentational strategies in collaboration with other institutions. For all such outside funding, significant institutional commitment to the project as evidenced by IDP support is essential. Finally, plans are being outlined for a complete reprogramming of our lesson authoring and presentation software to enhance flexibility and speed and to permit royalty-free distribution to other institutions.

A Fiber Optics Instructional Laboratory

Assistant Professor R. Stephen Weis
Electrical Engineering Department

Project Background

The goal of this work was to create a fiber optics instructional laboratory to teach future naval officers to understand and intelligently employ fiber optic systems in the fleet. The laboratory will be a valuable asset in several ways. First, at the advanced undergraduate level it will provide a means of reinforcing and applying previously learned electromagnetic theory. Second, it will provide a resource for fiber optics demonstrations for several courses. Third, it would be available and could be adapted for use in training other naval personnel during short summer courses.

Instructional Development

The HP computer workstation donated by the Hewlett-Packard company has been installed and is fully operational. A proposal for instrumentation funding under the Instrumentation and Laboratory Improvement Program was submitted to the National Science Foundation in November 1988. The money was granted to USNA and has been used to purchase a computer-controlled optical fiber measurement system.

A lecture demonstration for the Core EE courses was written and delivered to nine sections of EE312. The model structure in a few-mode fiber was demonstrated by separately exciting each mode. The fiber was also bent to demonstrate radiation losses and the effect on waveguide transmission.

Six two-week exercises were written. The titles and objectives of each are as follows: (1) Fiber Preparation and Numerical Aperature--to learn to prepare fiber ends for use in the laboratory, observe the geometry of a fiber, and measure the numerical aperature (NA) of a telecommunications-grade fiber; (2) Fiber attenuation Measurement--measure the attenuation per unit length of multimode communications-grade optical fiber using the "cutback method"; (3) Fiber Coupling--investigate the effects of misalignment on fiber coupling to understand connector and splice loss mechanisms, and to splice two fibers together and measure the splice loss; (4) Multimode Bidirectional Coupler--measure the excess loss, splitting ratio, and directivity of a fused bidirectional coupler; (5) Far Field Power Distribution of a Single-Mode Fiber--couple laser light into a 4 μm diameter core single-mode fiber, and measure the far-field power distribution of the fiber as a function of angle and compare it to a Gaussian approximation; (6) LP Modes in a Few-Mode Fiber--calculate, plot, and observe the first four LP modes in a few-mode fiber, and demonstrate that the HE_{11} mode is composed of two orthogonal linearly polarized components by observing the beat length in a polarization preserving fiber.

Product Use, Evaluation, and Publication

The material developed as part of this project will be used for the first time during the Spring semester of 1990 in EE487 - Fundamentals of Optical Waveguides. This work will be submitted to the journal *IEEE Transactions on Education* in two papers. One will describe the course and the labs, while the other will be a short note about the use of Mathematica to plot mode patterns.

Long Term Objectives

The long term objective of this work is to demonstrate to future naval officers that the *same* basic principles of time-harmonic electromagnetics apply to *all* the electromagnetic systems they may encounter.

Input-Output Courseware

Professor A. Royall Whitaker
Economics Department

Project Background

Interindustry economic analysis is on the ragged edge between macroeconomic analysis and microeconomic analysis. It is the study of relationships among intermediate producing and using sectors and final using sectors for the purpose of tracing all the direct and indirect effects of changes (price, quantity, or technology) in any one sector. It can be approached either as the aggregation of many small microeconomic sectors or as the disaggregaton of a few large macroeconomic sectors, and can therefore naturally be taught in either macro theory or micro theory courses. In addition, the techniques it comprises have applications in defense economics, international trade, and economic geography courses. Unfortunately, teaching it is also so time-consuming that it is usually not taught at all.

Interindustry economics was pioneered in the late 1920's and early 1930's by Leontief at Harvard (for which he received the 1973 Nobel prize in economics), and was adopted by the Commerce Department in the early 1930's. Early applications included both smoothing the mobilization for World War II and planning for demobilization afterward, and the Department of Defense currently maintains an interindustry model called DEIMS - Defense Economic Impact Modeling System. The Department of Commercce itself has a separate interindustry economics office which maintains several models, one of which includes more than 500 sectors. Separate interindustry economics courses are taught at several universities, and one very good textbook is available. Although the input-output techniques Leontief developed are generally considered to be synonymous with interindustry economics, I-O (as they are commonly abbreviated) techniques are applicable also to single firm problems, and the bibliography includes masters degrees theses at Monterey and at the Air Force Technical Institute.

Instructional Development

The chief obstacle to teaching interindustry economics is that it involves the use of simultaneous equations to analyze input-output tables, and this in turn normally involves the study of matrix algebra - this seems to be the presentation in all text material. The only alternative for students is simply to plug into canned simultaneous equation programs and marvel at the results. In an undergraduate economics program, a term of matrix algebra would probably not seem to be a very economical investment of time by most students, and if we tried to teach it ourselves there would be that much less time for teaching economic applications. As a practical matter, therefore, I-O has been inaccessible to our students.

Personal computer spreadsheets, however, present an easy alternative to learning matrix algebra. A student who already knows the personal computer, even if he or she has never used spreadsheets, can easily learn to use circular arithmetic for solving a useful variety of input-output problems. For an intuitive understanding of economic adjustment processes, the spreadsheet approach is actually better than matrix algebra because it can so easily be slowed down in order to present one round of adjustment at a time. The authors of the leading text have included two "round-by-round" demonstrations of the application of circular arithmetic, and the principal task in this project has been to devise others.

The output is a 40-page manual which includes 18 spreadsheet exercises in a half-dozen categories. The first section illustrates the solution of a pair of supply and demand equations by circular arithmetic (including discussion and illustration of the non-convergence problem) and then illustrates the "classical" input-output problem of tracing all the effects of changes in the composition of final demand. Inasmuch as the first example is inherently a microeconomic problem, the second example is developed in terms of macroeconomics. Following are illustrations of several other I-O applications, such as labor shortage, labor surplus, technological change, and change in some labor costs. The labor-cost example is the "show piece" of the project in the sense that it enables students to solve, using nothing more demanding than 8th-grade arithmetic, a problem which normally depends on several pages of very tedious matrix algebra in addition to a general background in matrix algebra.

What is still to be done involves interregional problems and detailed defense applications based on DEIMS, the Defense Economic Impact Modeling Simulator. However, the conceptual problems have been worked out, further developments will be on a normal course-developed basis, and further special support will not be requested.

Some of the early assignments have been used in two sections of the introductory economics course to illustrate the direct and indirect consequences for all sectors of a change in consumer demands on two of the sectors, and to illustrate the direct and indirect consequences in all sectors of changes in labor costs in one sector. In at least one section of the microeconomic course, the entire manual will be used in connection with a chapter on general equilibrium. Other applications are planned for geography, trade, and defense economics. In a related development, circular solution of Markov chains - involving, for example, population shifts and employment shifts - has aroused some interest in the department.

Each example is validated in the sense that the spreadsheet solution can be tested against the textbook solution. An alternative approach to labor shortage and surplus may be publishable as a substantive contribution to the I-O literature.

Interactive Computer-Video and On-Screen Computer Lessons in French

Professor John D. Yarbro
Language Studies Department

Project Background

The USNA Language Department has long been a leader in using audio-recorded materials for group practice, homework, and testing. Since installing the first USNA earth satellite receiving station in 1984, the Department has pioneered in instructional use of foreign language video. The investigator created the first interactive computer-video (IAV) lessons, using laser-read videodiscs, and integrated them into third-year French programs starting with AY 1986-1987.

Subsequently, with substantial outside funding, the department has conducted the Annapolis Interactive Video Project. This large-scale project has emphasized faculty team production and systematic evaluation of weekly IAV lessons for basic and intermediate students in Spanish. Another faculty member has developed videodisc programming in Russian. For hardware support, the department has 128 laboratory audio carrels, 50 of them also equipped with computers, video monitors, and laserdisc players.

Besides video and interactive video lessons, the investigator has created computerized practice lessons in French using the Computer Assisted Language Instruction System (CALIS), originated by Duke University.

Instructional Development

Procedures and products are as listed.

a. Collect authentic native-French video materials recorded on USNA earth satellite receiving station. Purchase available French TV broadcasts, plays, films, travelogues, etc., on videocassettes. Product: Growing inventory of French videocassettes (now at 40+),

b. Select best segments to adapt as video or interactive computer-video lessons. Edit segments for recording on laser-read videodiscs. Product: Three new French videodiscs, with 38 program segments,

c. Design and create video or computer-video lessons from chosen TV segments, with appropriate practice guides and scripts. Product: Twenty-three IAV, computer-videodiscs, or video lessons now integrated into FF301-302 Advanced French programs. More to come.

d. For on-screen computer lessons using CALIS, design and create lessons that parallel and reinforce homework assignments for texts, supplementary study sheets, and audio cassettes. Product: Eighty Calis lessons, distributed to midshipmen on ten individual diskettes, for practice on their own PC's.

Product Use, Evaluation, and Publication

Lessons using videocassettes, laser-read videodiscs, and interactive computer-video are now an integral part of the syllabus for FF301-302 Advanced French, which is directed by the investigator. In this and other courses, we now offer extensive opportunities for midshipmen to comprehend and imitate French as it is actually spoken, by natives, in their home environments and in all kinds of situations.

In particular, the interactive computer-video lessons oblige the students to react to scenes, dialogues, narratives--and allow them to replay a segment as often as necessary. As an alternative to living with native speakers, this is a life-like way of learing to comprehend many kinds of speech.

The CALIS exercises supporting daily assignments have definitely improved the written homework required of midshipmen in FF301-302. Students can do the parallel exercises on their computer diskettes while listening to the same material on their audio cassettes. They get immediate diagnostic comments on their responses.

Observations by faculty members, visiting educators, and midshipmen users bear witness to the unique value and effectiveness of these new learning materials. Following are indicative comments by midshipmen in FF301: "I found it extremely helpful to have all of the resources available...namely the audio cassettes, the computer diskettes, and the video presentations." "The television programs were particularly interesting and helpful." "The computer programs were very helpful." "Computer disks were great!" "The texts, cassettes, and computer disks effectively presented the course material. I developed...not only the necessary vocabulary and grammar, but the comprehending ability I needed."

The investigator has shared video materials with interested colleagues and has demonstrated interactive computer-video lessons in French to them, as well as to many outside visitors. The investigator has also taught several colleagues how to create CALIS lessons, (Assistant Professor Landers, for example, has developed a full series of CALIS lessons for Beginning Spanish.); and has discussed the project and The Annapolis Interactive Video Project in sessions of the Northeast Conference on the Teaching of Foreign Languages in New York.

Long Term Objectives

The investigator aims to continue regular collection of authentic French video programs, choosing the best segments for recording on videodiscs. Upgrading techniques and software, the investigator intends to create more lessons based on videodiscs, with growing emphasis on materials for independent use by midshipmen in the language lab. A number of these lessons will be fully interactive, requiring computer responses to visual or audio cues and furnishing immediate feedback to the learner. Also the investigator aims to upgrade and expand the inventory of CALIS lessons. In all these activities, the researcher will seek to promote use of new technologies among colleagues.